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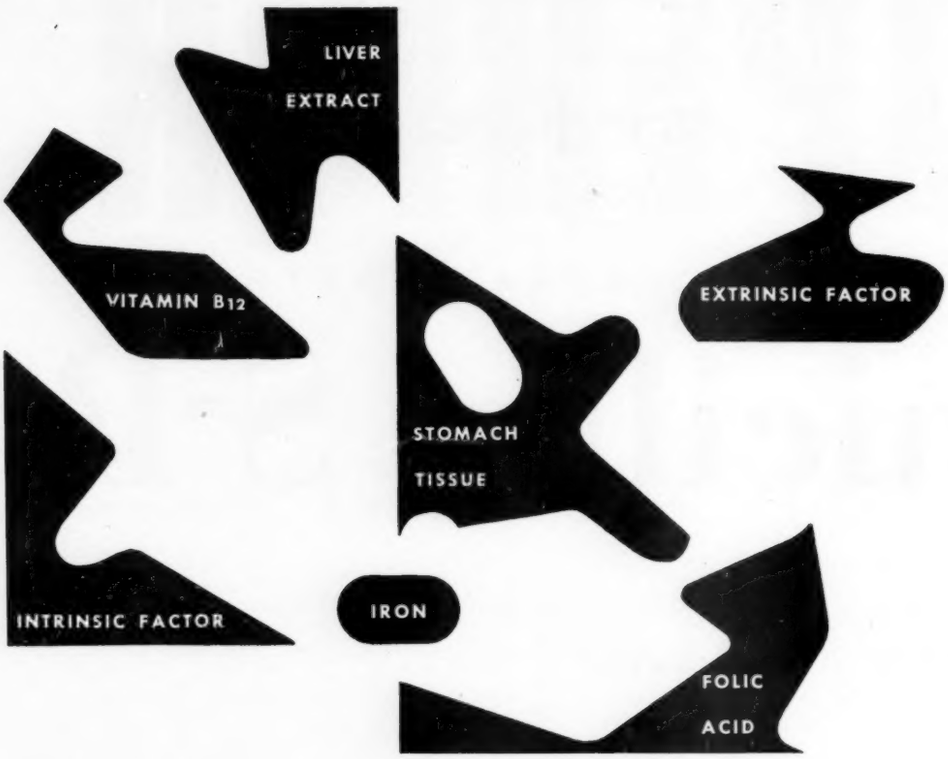

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Editorial

SURGICAL PROBLEMS ARISING DURING PREGNANCY . . . . . *R. Gordon Douglas* 1

Original Articles

MANAGEMENT OF DIVERTICULITIS OF THE SIGMOID COLON . . . . . *Harry E. Bacon and Lloyd F. Sherman* 3

One hundred seventeen cases of sigmoidal diverticulitis were treated by the authors. Of this number forty-one were submitted to surgery. It is concluded that prior to surgical intervention each patient's condition must be carefully weighed, particularly in relation to the procedure best suited.

TREATMENT OF MAJOR TRIGEMINAL NEURALGIA THROUGH SECTION OF THE TRIGEMINOSPINAL TRACT IN THE MEDULLA *Rupert Raney, Aidan A. Raney and C. R. Hunter* 11

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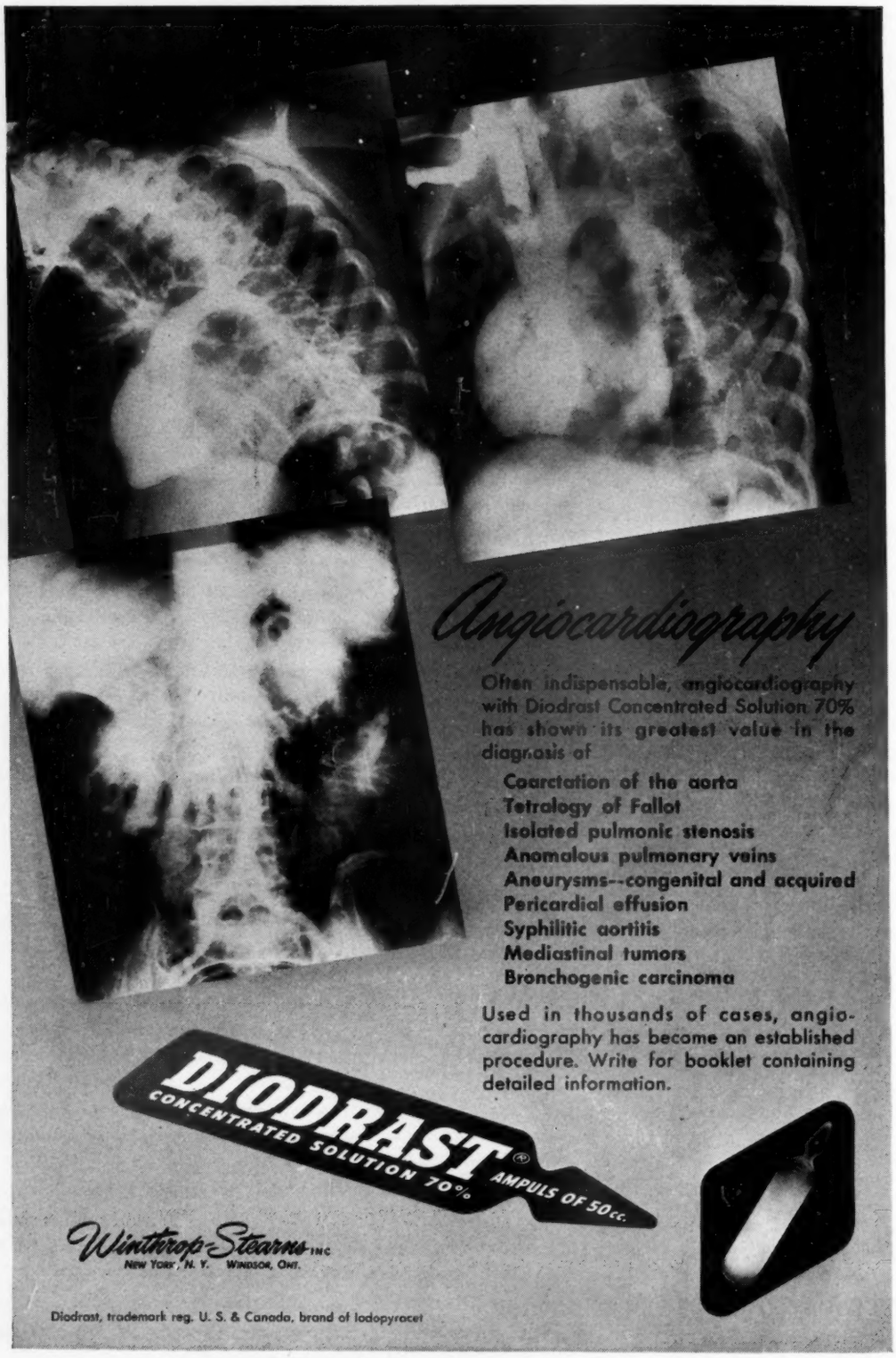
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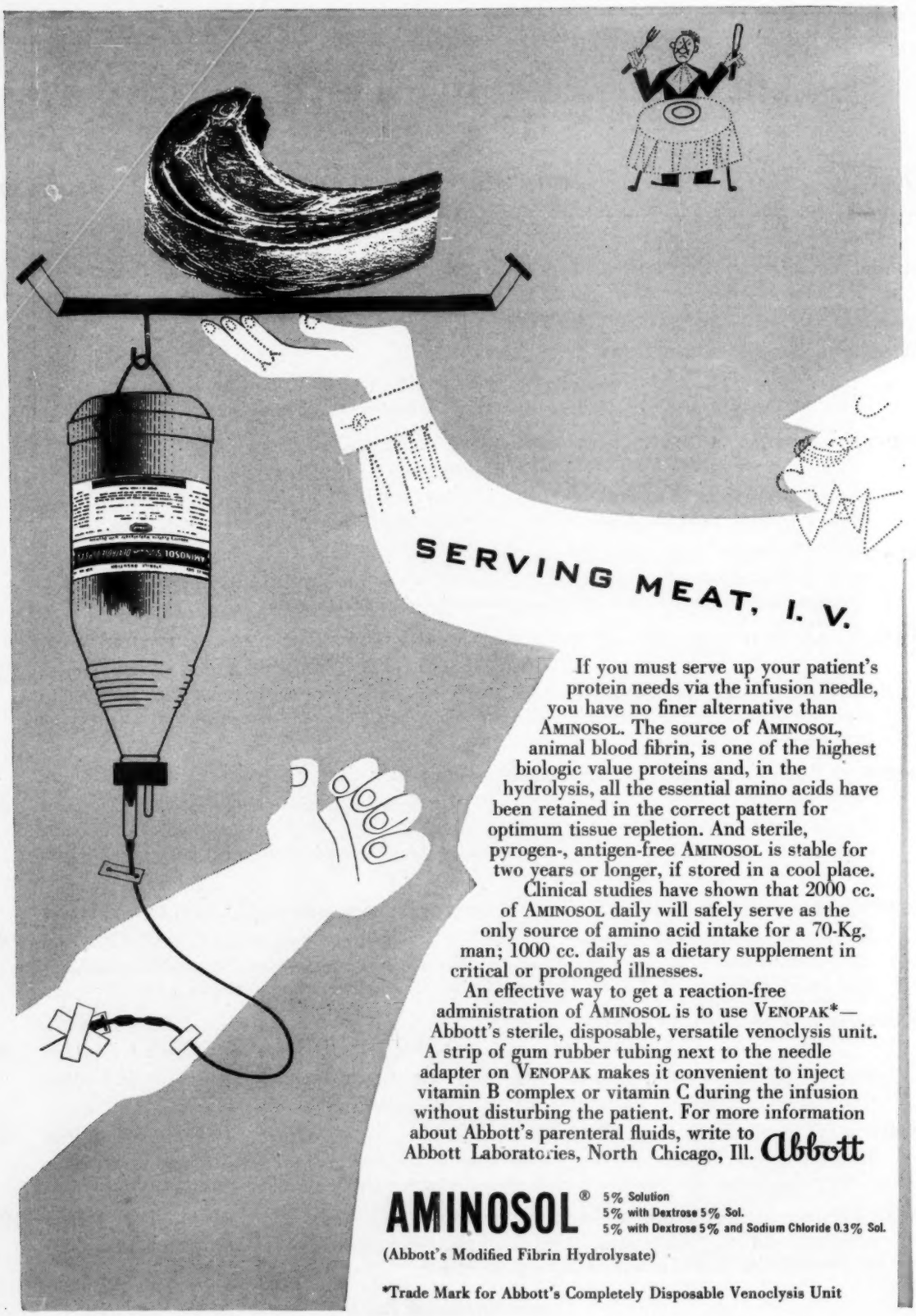

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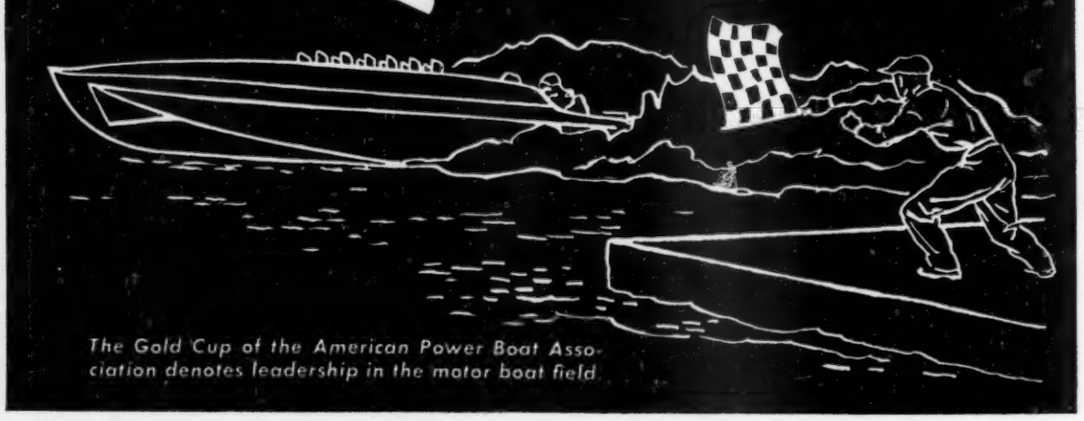

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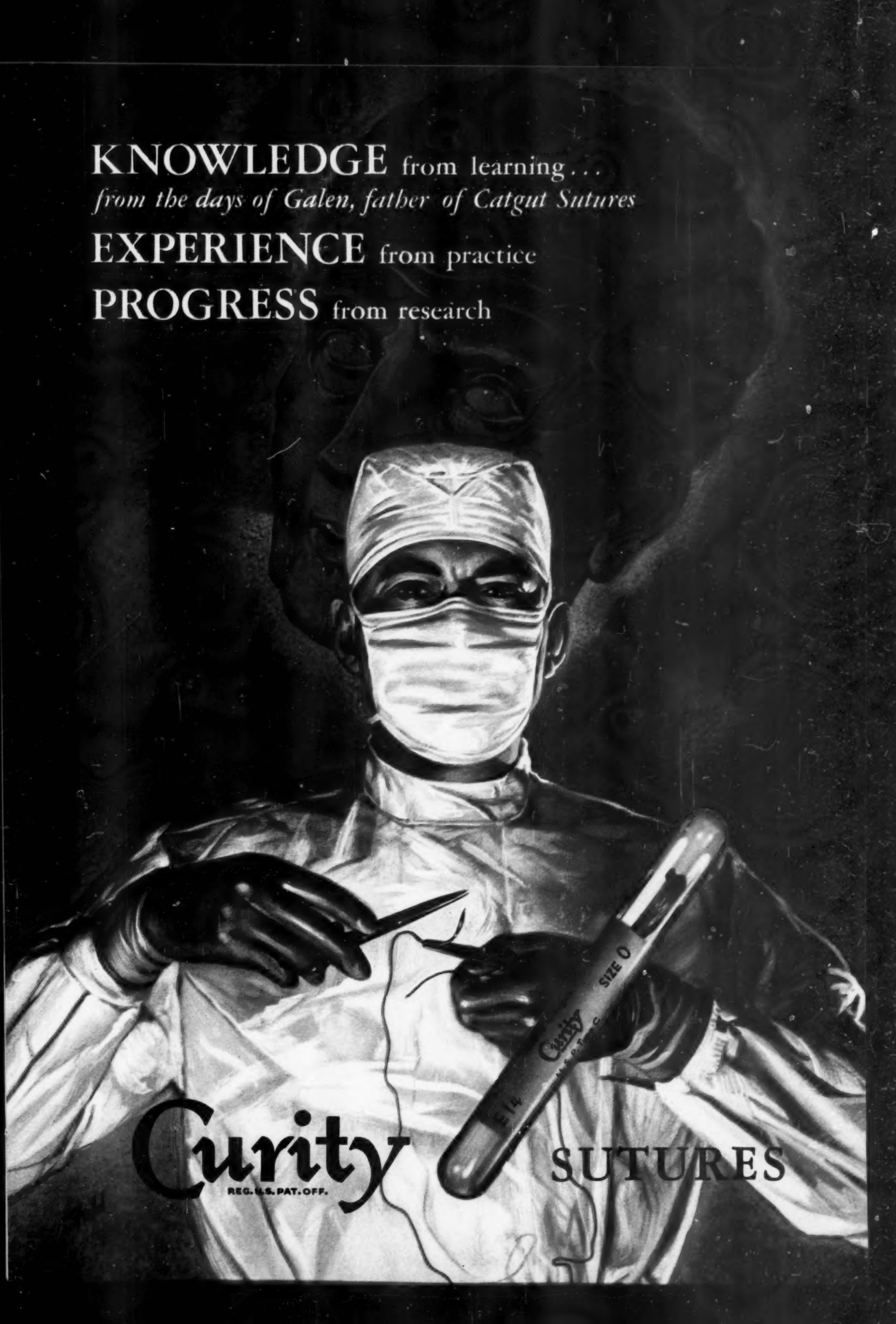
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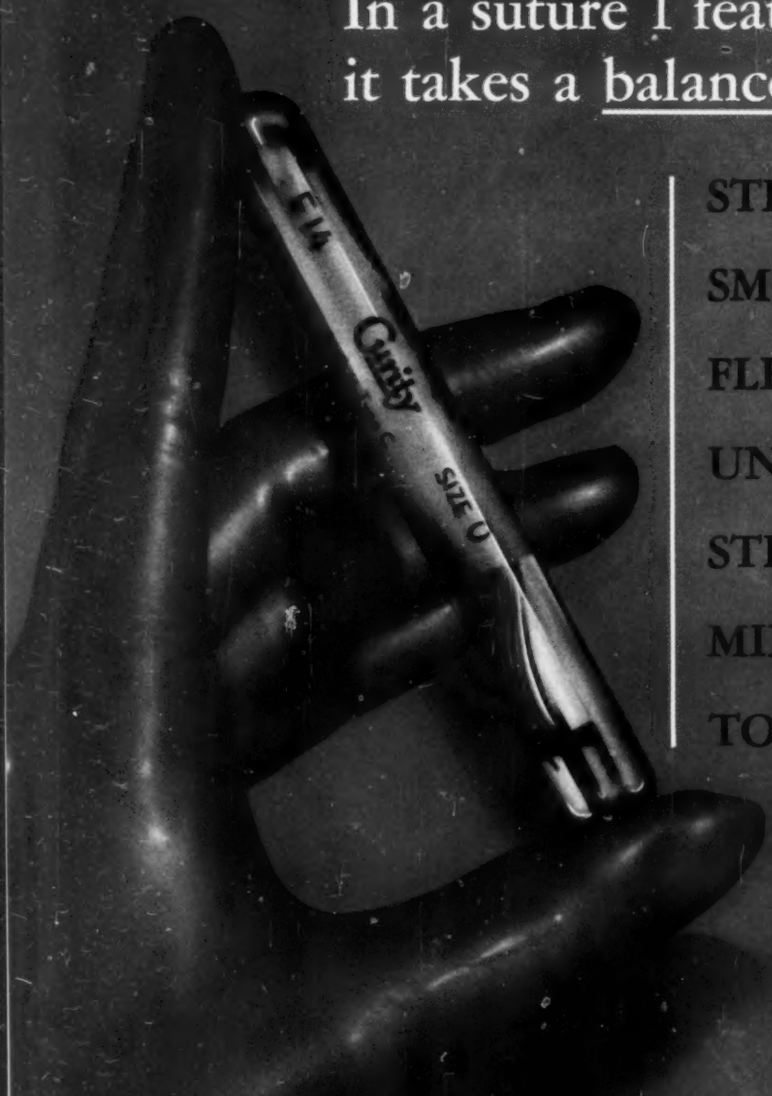

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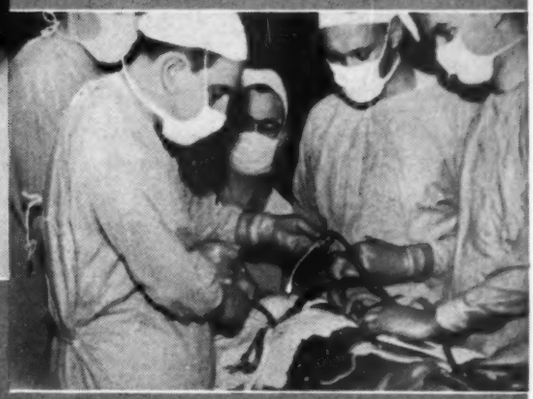

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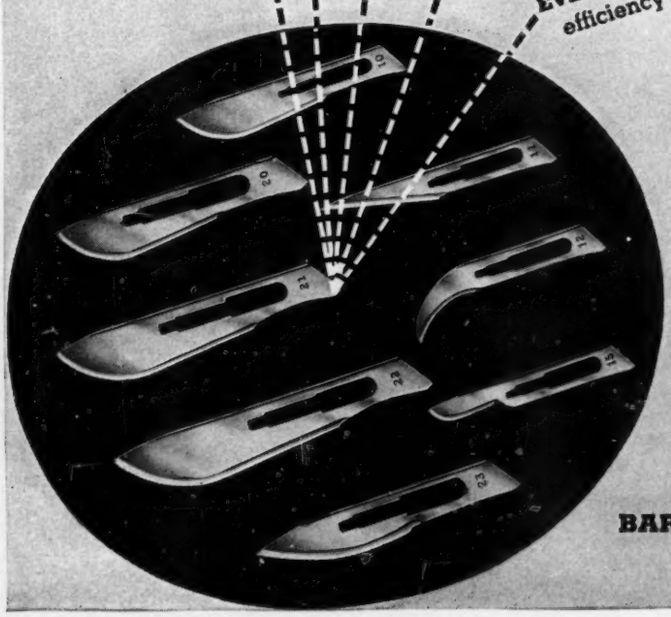

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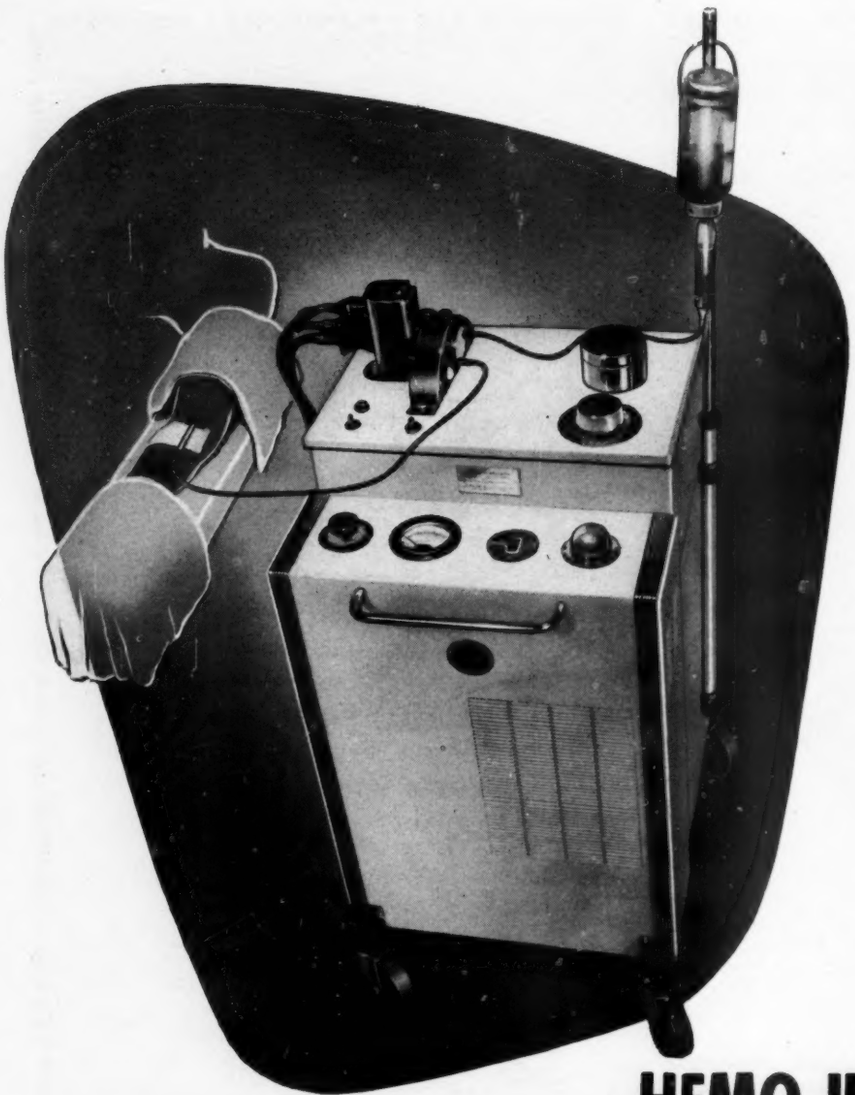

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Irradiated Blood Transfusions in the Treatment of Infections: Northwest Med., June, 1934.

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- This procedure is reported in this issue under the title "Use of Ultraviolet Blood Irradiation (Knott Technique) in Biliary Tract Surgery" on Page 108.

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METHOXAMINE HYDROCHLORIDE INJECTION

a NEW superior pressor agent for safely maintaining or restoring blood pressure levels during spinal anesthesia and surgical procedures

Discovered at
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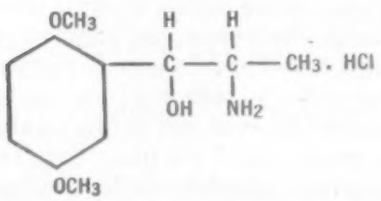

EFFECTS: **During operations under spinal anesthesia 'Vasoxyl' has been found by Dripps,[4] by Kistler and Ruben[5] and other investigators to be a superior drug for maintaining blood pressure.**

During cyclopropane anesthesia Stutzman et al.[2] find 'Vasoxyl' a "safe pressor agent."

Intramuscular injection of 15 mg. 'Vasoxyl' produces a prompt and prolonged rise in blood pressure, *without central stimulation and without causing cardiac irregularities even during cyclopropane anesthesia.*

PACKAGING: **'Vasoxyl' brand Methoxamine Hydrochloride Injection 20 mg. in 1 cc., boxes of 12 and 100 ampuls.**

BIBLIOGRAPHY:
1. *Baltzly, R., and Buck, J. S.: J. Am. Chem. Soc. 64:3040, 1942.*
2. *Stutzman, J.: J. Pharm. & Exptl. Ther. 97:385, Dec., 1949.*
3. *Hjort, A. M.; Randall, L. O., and de Beer, E. J.: J. Pharm. & Exptl. Ther. 92:283, 1948; de Beer, E. J., and Dews, P. B.: To be published.*
4. *King, B. D., and Dripps, R. D.: To be published.*
5. *Kistler and Ruben: To be published.*

BURROUGHS WELLCOME & CO. (U. S. A.) INC., TUCKAHOE 7, N. Y.

Outside the Ivory Tower

A "LOSS of the sense of personal responsibility" by general practitioners for the welfare of their patients has been one of the principal effects of Britain's National Health Service program, Dr. Willard C. Rappleye, dean of the Faculty of Medicine at Columbia University, declared in a speech at Chicago.

In his address, prepared for delivery at the forty-sixth annual Congress on Medical Education and Licensure at Chicago's Palmer House, Dr. Rappleye cited "a reduction in the initiative and incentive for self-development" on the part of many general practitioners. Dr. Rappleye studied the British medical program, first-hand, in a visit to England last fall.

MANILA, the Philippines—It is probably not your room-boy for here in Manila he has police papers clearing his character and health. But once you step out of your hotel onto bay-front Dewey Boulevard, it may be the waif who sells you your newspaper. It may be the sad-eyed girl selling cigarettes from her sidewalk stand on busy Escolta or the stiff-fingered, crippled vendor selling his popcorn in Luneta Park on the site where the hero, Rizal, was murdered by the Spanish. Again, it may be the pain-ridden old woman you glimpse on her cot in a dark corner as you pass the door of her miserable barong-barong. But wherever you go in Manila, you will come very close to them. For there are 5,000 of them at large in the city, at large or dying slowly and painfully in the solitude of their huts. They are lepers, victims and carriers of a disease that man for centuries has dreaded more than any other.

[We have heard, on reliable authority, that lepers "at large" are not unusual in the U. S. In New York City, for example, they are said to number several score. Ed.]

IN 1949, for the third successive year, the number of marriages in the United States showed a decline. Provisional data indicate that the figure for the year was about 1,580,000, or one-eighth less than in 1948 and nearly one-third under the peak reached in 1946. The marriage rate dropped from a high of 16.4 per 1,000 population in 1946 to 10.6 in 1949, that is, to approximately the prewar level. This decrease reflects in large part the reduction in the number of unmarried men in the population.

IN Italy in the sixteenth century there was a rough, tough soldier by the name of Camillus. He was a roisterer and had been in and out of jail several times. He reformed and joined a religious order. He worked in one of the hospitals of Rome. There was an outbreak of dysentery among the babies of that city and the death rate was appalling. The former soldier, later canonized St. Camillus, gathered up the sick in the highways and byways and brought them to his hospital. There they were bathed, given plenty of fresh air and fed goat's milk. The epidemic was stopped and the mothers of Rome forever afterward sang songs of praise to St. Camillus. It was he who founded, in 1584, the first nursing order devoted exclusively to the care of the sick. It was during this period that he wrote, "If you wearily do a good thing, the weariness passes and the good remains."

The spirit of Christian sacrifice exemplified by this rough humanitarian of the sixteenth century is exactly that which has characterized the lives of our country practitioners since the very beginning of our nation. If physicians are regimented, is it not reasonable to assume that this flaming spirit will be extinguished?

John J. Rainey, M.D., Troy, N. Y.
[Letter to the Editor—Published J. A. M. A.]

ABOUT 1,200,000 persons were involved in divorces granted in the United States in 1948. The total includes 313,000 children of broken marriages who were under twenty-one years of age when their parents were divorced.

"Divorce in families where there are children is more common than is generally realized," observed the statisticians. "Of the 421,000 absolute decrees granted, 42 per cent were to couples with children."

(*continued on page 28*)

Terramycin

Effective against a wide spectrum of bacterial, viral, rickettsial agents, and certain important protozoan organisms.

Terramycin

is available in 250 mg. capsules, 16 to the bottle. Dosage range—depending on the infection being treated—is from 2 to 3 grams daily in divided dosage.

indicated for: *acute pneumococcal infections, including lobar pneumonia, bacteremia; acute streptococcal infections, including erysipelas, septic sore throat, tonsillitis; acute staphylococcal infections; bacillary infections, including anthrax; urinary tract infections due to E. coli, A. aerogenes, Staphylococcus albus or aureus and other Terramycin-sensitive organisms; brucellosis (abortus, melitensis, suis); hemophilus infections, including whooping cough (exclusive of meningitis); acute gonococcal infections; syphilis; lymphogranuloma venereum; granuloma inguinale; primary atypical pneumonia; herpes zoster; typhus (scrub, epidemic, murine); rickettsialpox; amebiasis (Endamoeba histolytica).*

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In Office, Home, Operating Room and All Cleansing Procedures

You'll say it's a top quality bar of hard-milled soap—yet its ingredients give results never obtained from any soap.

Gamophen contains hexachlorophene (2%),* the most effective, longest-acting skin antiseptic known. The soap base was specifically selected to provide optimum release of hexachlorophene's bactericidal properties, without irritating or drying the skin. Gamophen has been tested in 3½ years of laboratory and clinical evaluation.

WHAT YOU GET IN GAMOPHEN

Bactericidal action. Sustained low count in regular use. Emollient effect—no irritation. Quick, rich lather in any water. An excellent deodorant. Economy—less than half the cost of liquid soap. Tremendous Time Saver—3-minute scrub is sufficient.

Prolonged Antibacterial Effect

Hexachlorophene exerts a prolonged antibacterial effect against resident flora of the skin, gram-positive and gram-negative organisms, pathogenic and non-pathogenic bacteria.

Several investigators have found that the standard scrub of 15 or 20 minutes may safely be reduced to from 3 to 6 minutes when Gamophen is used.

In a series of comparison tests it was found that the bactericidal action of Gamophen was 36% greater against mixed cultures of S. aureus,

*"Hexachlorophene" has been accepted by the Council on Pharmacy and Chemistry of the American Medical Association as the generic term for dihydroxyhexachlorodiphenyl methane.

GAMOPHEN ANTISEPTIC

ETHICON SUTURE LABORATORIES
INCORPORATED
NEW BRUNSWICK, NEW JERSEY

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Emollient, Rich-Lathering, Fast-Acting Continuously-Effective, Economical

S. hemolyticus and E. Coli, and 10% greater against Cl. welchii, than 3½% tincture iodine.

When used routinely for all cleansing occasions in hospital, office and home, Gamophen establishes a protective anti-bacterial film which exerts a continuous action. The marked degree of suppression achieved is maintained as long as this soap is used regularly and for several days after its use is stopped. The use of alcohol or other solvent rinses is contraindicated.

Bactericidal in 3-minute Scrub

Gamophen Soap is alkaline in solution, with a pH of 8.5 to 9. It is bactericidal in a 3-minute scrub in the concentrations used in normal scrub conditions. It quickly produces a thick, rich lather, even in hard and cold water. Every lot produced is tested for potency.

WHERE TO USE GAMOPHEN

In office and home. In the hospital wherever soap is used—by staff personnel or patients. For pre-operative antisepsis of skin. Industrial clinics and first aid stations.

In other tests, hexachlorophene in Gamophen was found to be more effective than it was in other vehicles, such as certain liquids having an acid pH, in which it is bacteriostatic but not bactericidal. Liquid solutions having an acid pH lower the effectiveness of hexachlorophene.

Gamophen is supplied in 4½-oz. bars for home and office; in 2-oz. bars for hospital personnel and patients' use.

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PHOSPHORUS	1.5 Gm.	0.206 Gm.	14
VITAMIN A	5000 I.U.	193 I.U.	4
THIAMINE	1.5 mg.	0.17 mg.	11
RIBOFLAVIN	1.8 mg.	0.24 mg.	13
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**1 oz. of breakfast cereal, 4 oz. of milk, 1 teaspoonful of sugar. Based on composite average of all breakfast cereals on dry weight basis.

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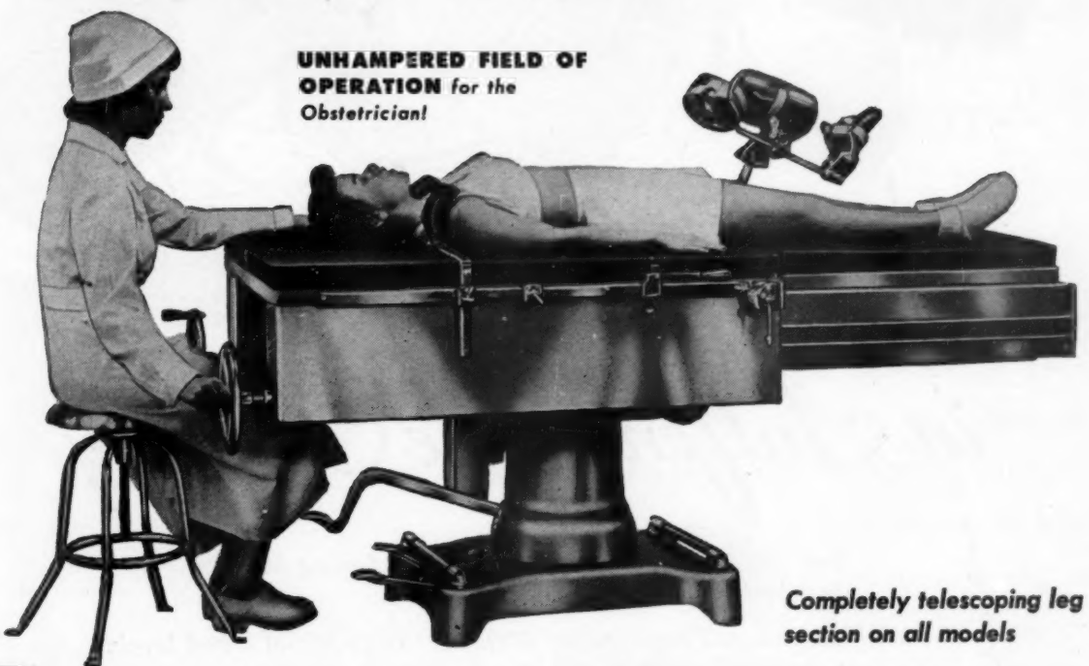

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Consult your dealer today for information on the complete line of Shampaine designed O.B. Tables.

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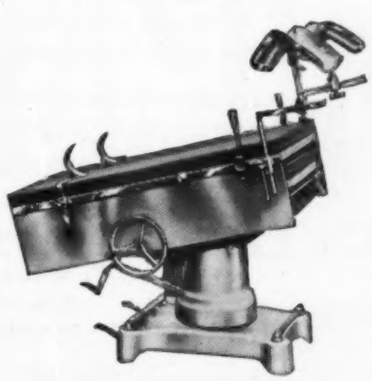

—provides the same positioning features as the Hampton Table, but offers an economy in the side-wheel Trendelenberg control and manual leg section.

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Full sulfonamide dosage without any feeling of apprehension over renal complications.

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(Queries & Minor Notes, J.A.M.A. 141: 300, Sept. 24, 1949)

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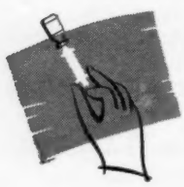
Mixed with Water For Injection, U.S.P., or Isotonic Sodium Chloride Solution, U.S.P., Com-Pen quickly forms a homogeneous suspension. Its particles of procaine penicillin G are uniformly dispersed due to the presence of small amounts of harmless dispersing agents. A minimum of agitation is required prior to aspiration.



Because of the high degree of subdivision of its procaine penicillin particles, Com-Pen is easily aspirated through a 20-gauge needle prior to injection. Prepared suspensions of Com-Pen may be kept at room temperature for one week, or at refrigerator temperature for three weeks, without significant loss of potency.

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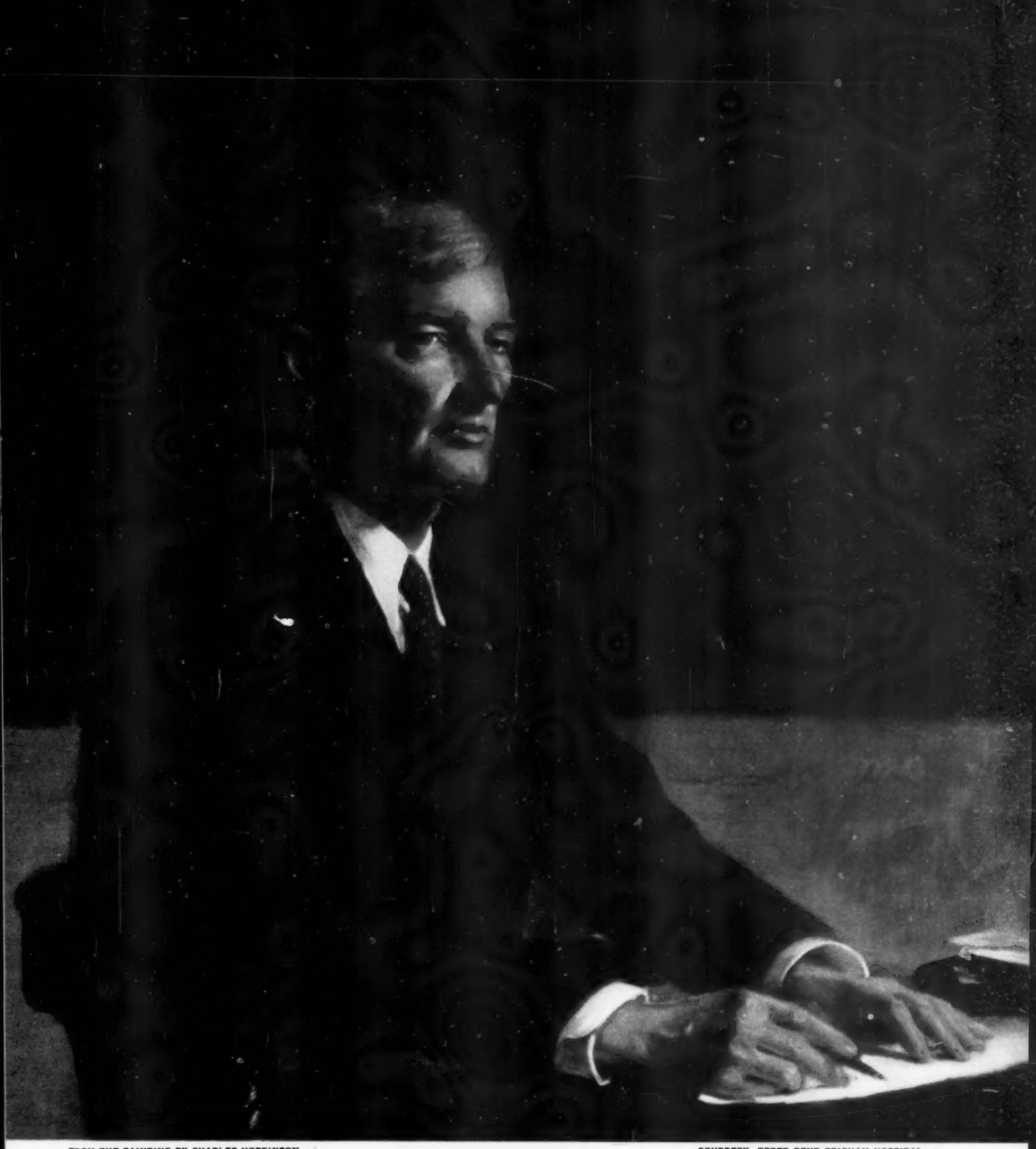

FROM THE PAINTING BY CHARLES HOPKINSON

COURTESY, PETER BENT BRIGHAM HOSPITAL

Elliott Carr Cutler

1888-1947

Dr. Cutler received his M.D. at Harvard in 1913, and began his career as surgical house officer at Peter Bent Brigham Hospital. In 1915 he was resident surgeon at Massachusetts General Hospital.

In World War I he was in charge of the first Harvard Medical Unit in Paris. In World War II he entered the Medical Corps, attaining the rank of Brigadier General. He served with distinction as chief consultant in surgery and as chief of professional services in E.T.O.

Dr. Cutler was Moseley professor of surgery at Harvard University Medical School and at the graduate school in Boston; he was also chief surgeon at Peter Bent Brigham Hospital.

He was a fellow of the American College of Surgeons, a founder of the American Board of Surgery, a member of the Society of Clinical Surgery, Association for Thoracic Surgery, Society for Clinical Investigation, Society of Experimental Biology and Medicine, American Society for Experimental Pathology and many other scientific groups.

Dr. Cutler was author, with Dr. Robert Zollinger, of "Atlas of Surgical Operations."

From the Series, Great American Surgeons, Published by Ethicon Suture Laboratories, Inc., New Brunswick, N.J.

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Night scene of Ethicon Laboratory Building at New Brunswick

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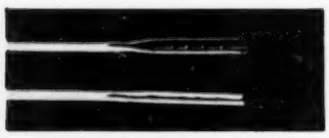
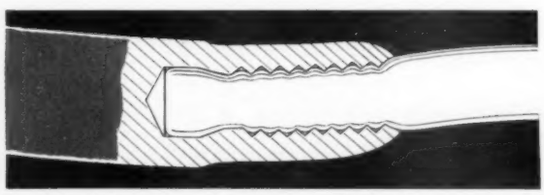
ONE TEMPER THROUGHOUT—NO SOFT SPOTS OR BRITTLENESS



CONVENTIONAL SWAGE



Cross-section of swaged end of Ethicon Seamless Needle. End is drilled and threaded. Suture is screwed in position. Needle is cold-pressed to establish absolute grip on suture.

ETHICON SEAMLESS SWAGE

GREATER STRENGTH, LESS BULK FROM EVEN-TEMPERED STEEL

Surgeons are offered new refinements and dependability in use in the Ethicon Seamless Swaged needles.

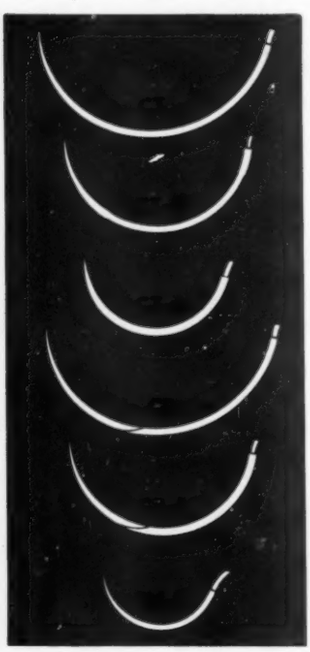
Their exclusive design is based on a new construction principle, devised by Ethicon engineers and metallurgical consultants.

The surgeon gets a needle with an unbroken surface from end to end, without brittleness or soft spots. The process permits complete control of every stage of manufacturing. Uniform strength of the steel is maintained by the electrical method of tempering the needle.

The result is a smaller diameter, yet stronger needle with optimum flexibility and maximum stiffness.

The shorter swage permits a longer, more useful flat area which also does not turn in the needle holder.

As the illustrations above show, the Ethicon Seamless Needle is free from the possibility of rough seams, often found in the conventionally swaged needle.



FOR ABDOMINAL CLOSURE, SIX NEW NEEDLES SERVE MOST ALL USES

For Ob., Gyn. and general closure, sutures swaged to eyeless needles are winning acceptance through their many benefits.

The Ethicon Seamless Needle draws a single strand of suture through the tissues, with minimal tissue trauma and added speed and ease of use.

The Seamless Needles have uniform curvature and improved cutting points with constant sharpness. They are hand-honed and individually inspected. Fewer sizes and varieties are needed. Time of nurses is saved in release from threading and in preparation of sutures requested by the surgeon.

After extensive research in surgeon's preferences, Ethicon designed the 6 needles shown at the left, which meet the requirements for 80% of the needles used in abdominal closure.

These needles are swaged to Ethicon's Tru-Gauged, Tru-Chromicized Surgical Gut, noted for its strength and flexibility.

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The American Journal of Surgery

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A PRACTICAL JOURNAL BUILT ON MERIT

Fifty-ninth Year of Publication

VOL. LXXX JULY, 1950 NUMBER ONE

Editorial

SURGICAL PROBLEMS ARISING DURING PREGNANCY

MINOR operations, both gynecologic and general surgical, such as incision and drainage of abscesses and excision of benign tumors fail to present any significant surgical or obstetric problem. Consequently, further discussion of this category may be dismissed. Major non-abdominal operations, however, deserve somewhat more consideration. In cases in which the diagnosis of malignancy has been established (e.g., breast tumors), necessary surgery and radiation therapy if indicated should be undertaken irrespective of pregnancy. Thyroid surgery and craniotomy for benign lesions may likewise be performed provided that the operative procedure cannot safely be deferred until the pregnancy has been terminated. A wide experience indicates that the adoption of such a policy is in the best interests of the patient and does not interfere with the pregnancy.

Major abdominal operations may be divided into general surgical and gynecologic categories. The former group may be further subdivided into operations for acute appendicitis and those performed for other pathologic entities such as acute cholecystitis, intestinal obstruction, strangulated hernia, bowel perforation, abscess and malignancy. The significant feature of the majority of these lesions is that they represent acute problems requiring more or less immediate surgical intervention. With the institution of prompt surgical treatment excellent maternal results are usually obtained and the possibility of abortion minimized. With delay, however, complications are encountered and fetal loss is increased.

Acute appendicitis deserves special consideration. Many studies indicate that by far the greatest number of cases are recognized during early pregnancy. Secondly, when appendicitis does occur late in pregnancy, it manifests itself in its more severe forms. Cases in which there are perforation peritonitis, premature labor and death occur more commonly during the latter months. It appears probable that appendicitis is nearly as common in the latter as in the early months of pregnancy, but that the diagnosis is made less frequently as the patient approaches term. The reasons for this failure to make the diagnosis are varied. Primarily the presence of the gravid uterus interferes with the usual typical localization of signs. Furthermore, correct evaluation of the multitude of vague abdominal signs and symptoms which tend to appear late in pregnancy is often difficult. Finally, many attacks of appendicitis subside spontaneously, leaving for the most part only the more serious instances of the disease to be recognized. The experience of many indicates that prompt surgical intervention in the early months of pregnancy results in insignificant maternal morbidity and abortion incidences. Improved results then can be produced only by extending early operation to those patients manifesting signs of appendicitis in the last trimester of pregnancy. If a policy of earlier and more frequent operation is adopted for what may seem at the time relatively benign symptoms and signs, it may be anticipated that a certain number of patients will be operated upon needlessly. In view of the insignificant risk involved it is apparent that this

is a small price to pay compared to the tragedy following procrastination and subsequent rupture. A large experience indicates that celiotomy for removal of the unruptured appendix may be done without danger to mother or fetus. A McBurney incision at the point of maximum tenderness represents the most satisfactory method of approach. It may be done at term and if labor supervenes the following day, no untoward results need be anticipated.

Unavoidably the diagnosis of acute appendicitis will not always be substantiated. The following conditions may occasionally be encountered: twisted ovarian cyst, salpingitis, pyelonephritis, torsion of fallopian tube or hydatid of Morgagni, pedunculated myoma, ectopic pregnancy. Experience indicates, however, that operation may be performed with relatively little danger of interrupting a normal pregnancy even if the diagnosis of appendicitis is not corroborated. Rarely the technical problem involved will necessitate another incision for better exposure. Under such circumstances the McBurney wound is closed and the more desirable incision made without significantly adding to the morbidity.

Gynecologic problems not infrequently are encountered in which the question of surgical intervention arises. Uterine myomas represent the most common tumors in the genital tract. Almost invariably these tumors undergo degeneration during pregnancy producing local signs and symptoms. Myomectomy or, indeed, hysteromyomectomy is not infrequently the ill-advised treatment resorted to. Myomectomy is associated with a high incidence of abortion in all cases except those in which the tumor is pedunculated. Accordingly, operation should be deferred and palliative therapy used. Only under unusual and exceptional circumstances should myomectomy be performed during pregnancy. Errors in the past have occurred in those cases in which such operations were performed. Furthermore, in those cases in which patients are treated conservatively the delay is never regretted. The size, position or some other feature of the tumor may indicate the necessity for removal at the time of delivery.

Ovarian tumors larger than 6 cm. in diameter should be removed during pregnancy. In general operation is better delayed until at least the sixteenth week in case it may be necessary to sacrifice the corpus luteum. Twisting of the pedicle or other complication may demand immediate intervention at any time. Benign tumors are always best resected, leaving as much normal ovarian tissue as possible. The advisability of being conservative at such a time cannot be stressed too strongly.

Carcinoma of the cervix is occasionally recognized during pregnancy. The disease should be treated in what appears to be the best interests of the patient. In the first half of pregnancy this usually implies loss of the fetus. During late pregnancy cesarean section is often indicated followed by the most appropriate treatment of the tumor depending on the stage of the growth.

The outlook in the future for patients who for various reasons present themselves with peritonitis will be far better than in the past for several reasons. First, the use of antibiotics and sulfonamides will contribute to reducing the septic process. Second, continuous enteric suction represents a great improvement in treating adynamic intestinal obstruction. Third, a better understanding of water, electrolyte and protein balance will aid in overcoming the acute illness. Fourth, the limitation of intervention to the surgical problem involved without attempted termination of the pregnancy has been found to give infinitely better results than were obtained when cesarean section or induction of labor was carried out.

Abortion following surgery appears to be directly related to uterine manipulation, the extent of peritonitis and the removal of the corpus luteum in early pregnancy. Surgery *per se* and anesthesia have no direct relationship to threatened abortion. Consequently in an uncomplicated appendectomy there is no apparent tendency for the patient to abort. Sedation and narcotics are of value in the postoperative phase to keep the patient comfortable. There is no conclusive evidence to justify the use of progesterone or other hormones to prevent the abortion during the postoperative period.

R. Gordon Douglas, M.D.

Original Articles

MANAGEMENT OF DIVERTICULITIS OF THE SIGMOID COLON

HARRY E. BACON, M.D. AND LLOYD F. SHERMAN, M.D.
Philadelphia, Pennsylvania

ALTHOUGH literature is profuse in its descriptions of every phase of diverticulitis, it is apparent from the varied opinions stressed that several aspects of this disease entity are still controversial. It has been estimated that approximately 10 per cent of all persons over the age of forty years possess diverticula of the colon. Of this group, it has been further calculated that in 15 per cent diverticulitis will eventually develop and that in 25 per cent of these patients indications for surgical intervention will develop. It is the purpose of this discussion to review the literature and our experience with diverticulitis, and to emphasize particularly its surgical management.

The nature and etiology of diverticula of the large intestine have offered a fertile field for study and speculation for several centuries. Littre[18] in 1700 mentioned "diverticular hernia" without explaining it. Fisher[11] has said that although the first description of diverticula of the intestine is usually attributed to Sömmering in his translation into German of Mathew Baillie's "Morbid Anatomy," in 1794 Voigtel cited previous cases which had been recorded by Schröch, Riolan, Günz, Morgagni and Haller.

The subject of diverticula of the intestine was discussed by Cruveilhier[6] in 1849. W. J. Mayo, Wilson and Giffin,[21] were the first to record a group of cases in which actual demonstration of the pathologic changes which occurred in diverticulitis was established during life. In the same year Moynihan[23] called attention to the mimicry of carcinoma to diverticulitis. In 1909 Giffin and Wilson[12] described the occurrence of peridiverticulitis, and in 1911 Wilson[33] described in detail the pathology, pathogenesis and complications of diverticulitis of the large intestine in which operation had been performed at the Mayo Clinic from 1902 to 1912.

The first preoperative roentgenologic demonstration of diverticula is attributed to Le Wald; the surgical aspects of this case were reported by Abbé in 1914. Comprehensive studies were reported by Rankin and Brown[26] who noted an incidence of 5.67 per cent in 24,620 roentgenologic studies of the colon. W. J. Mayo[20] reported an incidence of 5.71 per cent in 31,838 examinations in the period from 1924 to 1930.

Etiology. Many theories have been advanced in the literature to explain the manner in which diverticula of the colon develop in later life. The most commonly mentioned of these is concerned with herniation of intestinal mucosa near points of entry and exit of blood vessels. We believe that this is the most tenable hypothesis to explain the development of acquired diverticula of the large bowel. Other factors such as increased intracolonic pressure, the process of atrophy in the musculature of the aging intestinal wall, the narrower bowel lumen at the rectosigmoid and the horizontal plane of the pelvic sigmoid must be considered as contributory factors.

The terminal arteries as they approach the colon are made up of short and long branches; the former enter the bowel wall directly on the mesenteric side while the longer branches pass subserously directly toward the antimesenteric border and penetrate the muscularis to the submucous layers generally at or near the bases of the appendices epiploicae.[31] These sites represent the usual locations of the majority of the diverticula.

The mechanism described by Edwards[8] for the formation of acquired diverticula of the intestine is indeed adequate. He emphasizes the "weak spots" in the intestinal wall at the point where the blood vessels enter it. He ampli-

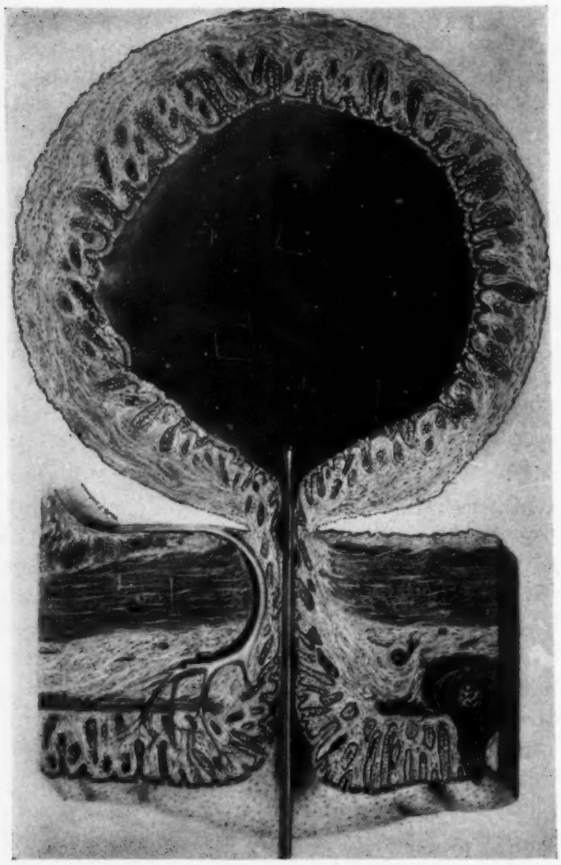

FIG. 1. Schematic drawing showing the layers involved in the formation of diverticula. Note that the herniation occurs at the point where the blood vessel pierces the muscle layer. The probe has been placed to show the characteristic constricted neck of the diverticulum.

fies this by pointing out that these vascular outlets become smaller during the period of contraction of the bowel. Conversely, they become larger during the period of relaxation. If contraction of two portions of the intestine occurs with a relaxed segment between them, the bilateral pressure will force the mucosa into the enlarged vascular outlets in the relaxed segment and thus produce initial herniation which may then progress to full diverticular formation.

As diverticula develop they expand into sac-like structures of varying sizes but they retain the small point of their origin which acts like a collar. This is an important factor in the subsequent development of diverticulitis. Fecal material enters the sac through the constricted neck and is confined therein by the small opening. The diverticula have little to no muscular coat and frequently cannot eject the offending material. As a result the foreign body becomes inspissated and stagnant, soon ulcerates the lining of the sac and sets up an infection of a mild or severe nature.[3] Undoubtedly, concomitant edema of the mucosa lining the neck of the sac contributes to the complete obstruction and a process ensues not too dissimilar to the obstructive type of appendicitis.

Henderson[14] has suggested that diverticula appear during or after an attack of inflammation in a section of the colon, and it is this initial inflammatory attack or series of attacks which constitutes a mechanism that brings about weakening of the wall. Fansler[10] stated that diverticula appear more frequently along the antimesenteric border of the colon and that diverticula occur at areas of weakness produced by degenerative changes in the muscularis. He does not believe that herniation of mucosa occurs at defects in the muscularis produced by the blood vessels. He further explains the frequency of diverticula in the appendices epiploicae by the loose adherence of the peritoneum to the bowel wall and consequent lessened resistance in these areas. (Fig. 1.)

Incidence. Diverticula of the colon are rarely seen in persons under the age of thirty years. However, several cases of diverticulitis occurring in the first decade of life are reported in the literature. Brown[5] estimates that approximately 4 per cent of diverticula of the large bowel occur in the thirty to forty year age group, and that about 95 per cent are encountered in persons forty years of age or older. Approximately 10 per cent of persons over the age of forty years have diverticula. It is not uncommon to find two or more instances in a family; Schlotthauer[30] has reported the occurrence of diverticula in seven brothers while two sisters had no diverticula.

The reported sex incidence of diverticulosis varies from equal distribution among males and females to a preponderance of 4:1 in males in Erdman's[9] experience. Fansler[10] stated that diverticulosis occurs in the male twice as frequently as in the female but the presence of diverticulitis is about equal in the two sexes. It is frequently stated that obese individuals are more likely to have diverticulosis than thin persons. W. J. Mayo[20] believed that neither obesity nor constipation is a real cause of diverticulosis.

Young and Young[34] in 1944 compiled statistics from the literature and found diverticulosis in 5.7 per cent of 70,572 colons examined at necropsy or roentgenographically. Pemberton and Black[25] reported diverticula present in 8.5 per cent of 47,000 colon x-rays taken at the Mayo Clinic.

Diverticula may appear anywhere in the various segments of the colon but they occur most frequently in the sigmoid. Martin and Caudle[19] in reviewing 119 cases of diverticular disease from Grady Hospital reported diverticulosis of the sigmoid colon, alone or in combination with other segments in 63 per cent of the cases, while the descending colon was involved in 80 per cent of the cases. They found the sigmoid colon was involved either alone or in combination with other parts, with diverticulitis, in 83 per cent of the cases, while the descending colon was involved in a similar manner in only 33 per cent. In seventeen of the 119 cases reviewed the patients were Negroes. Dixon[7] reported 80 per cent of all gastrointestinal diverticula in the sigmoid colon.

Pathology. Diverticula communicate with the lumen of the intestine and are capable of filling and frequently emptying; but when a fecalith occludes the narrow neck of the sac, edema of the mucosa with obstruction to emptying occurs. With retention of the contents and consequent irritation of the mucosa, inflammation occurs and the process of diverticulitis is at hand. From this stage there are several possibilities as to the future course. The inflammation may subside and the episode is then over. If this does not occur, one of several conditions may develop. Bacterial peritonitis may develop from extension without perforation of the inflamed diverticulum. This is rare, however. The inflamed sac may rupture and produce acute peritonitis. The inflammation may spread to involve the intestinal wall and other diverticula and thus produce the condition known as "peridiverticulitis," with narrowing of the lumen of the intestine and eventual obstruction after repeated attacks. A localized abscess may occur as a consequence of the diverticulum's perforation. Fistulas between the inflamed region and the bladder, vagina, abdominal wall or other intestinal segments may develop.

Arnheim[2] has collected the following statistics, relative to the complications of diverticulitis, from cases reported in the literature: Perforation with formation of abscess occurred in 19 per cent and peritonitis in 12 per cent of 834 collected cases. Formation of fistulas occurred in 8 per cent of 1,516 cases; the sigmoidovesical fistula was relatively frequent and more common in diverticulitis than in carcinoma of the sigmoid. Peridiverticulitis with narrowing of the lumen of the intestine and tumefaction occurred in 20 per cent of 1,049 cases.

The incidence of diverticulitis in cases of diverticulosis is not definitely known. Smithwick[32] has estimated that in one patient of ten with diverticulosis diverticulitis will develop. Pemberton and Black have calculated this incidence at 15 per cent.

SYMPTOMS AND DIAGNOSIS

The symptoms of diverticulitis may vary considerably according to the stage of the disease or the specific complication encountered in the individual patient. However, the classic syndrome of acute diverticulitis consists of crampy pain in the lower or left lower part of the abdomen associated with obstipation in about five-sixths of the cases and with diarrhea in the remainder. Nausea and vomiting are less striking symptoms unless considerable obstruction and peritoneal reaction exist. There may be a mild to moderate leukocytosis. Occasionally a mass may be palpable in the region of the sigmoid colon. Flatulence and low grade fever may be present.

The passage of slight blood with stools to massive hemorrhage may occur in 7 to 32 per cent of patients with diverticulitis according to various competent observers;[10,22,24,28,32] other authorities[5,13,27] are reluctant to admit that gross bleeding may be due to diverticulitis. Fansler[10] and Rosser[28] believe that bleeding is a not infrequent complication of diverticulitis. Rosser[24] quotes 50 per cent of sixteen patients with no other cause for gastrointestinal bleeding except diverticulitis after a thorough medical investigation. Of the 117 patients studied in our group, some degree of gross bleeding was noted by 18.0 per cent of the patients. It is our belief that carcinoma or bleeding from other sources should be suspected and definitely ruled out in all cases and particularly when a conservative regimen is elected.

In Table 1 are the symptoms cited in our group of 117 private cases.

Low back pain is stressed by Le Royer and White[17] as a diagnostic symptom of diverticulitis. They further add that this symptom has been little emphasized in the past and they believe it should be considered a part of the clinical picture. Pain in the lower back was noted in 20.5 per cent of 200 cases of diverticulitis at the Hartford Hospital.

When complications of diverticulitis arise, a new array of symptoms may become apparent.

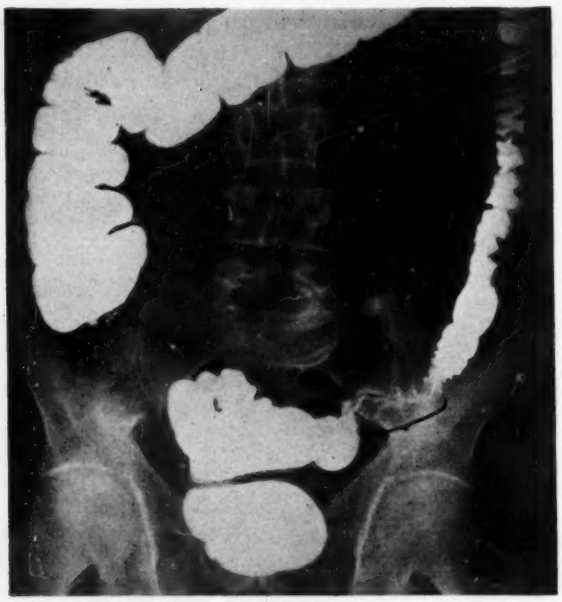

FIG. 2. G. R., aged sixty-one; barium enema reported diverticula and an inconstant defect of the sigmoid. Resection verified diverticulitis and peridiverticulitis with stricture formation.

When perforation has occurred, signs of peritonitis such as cramping lower abdominal pain usually are present and are associated with fever, chills and abdominal tenderness. If the process becomes localized and an abscess forms, a mass may soon become palpable in the lower abdomen and the febrile course will persist. Perforation and extension into the psoas muscle may occur in some instances. Here an abscess may not be palpable, but severe low back pain radiating down the anterior thigh may be the chief symptom. We are all aware of the frequent diagnostic confusion which arises in cases of women in whom so often a pelvic mass is mistaken for disease of the adenexa. Particularly is this more likely to occur when there are minimal symptoms of bowel dysfunction.

TABLE 1

Symptoms	No. of Cases	Percentage
Pain (abdominal)	98	83.7
Constipation	80	68.3
Diarrhea	13	11.1
Constipation alternating with diarrhea	15	12.7
Bleeding	21	18.0
Palpable mass in sigmoid (noted by patient)	23	19.6
Pneumaturia	19	16.3

Perforation of an abscess or an inflamed diverticula may involve the bladder, vagina, other loops of bowel or the abdominal wall with the formation of a fistula. The formation of a sigmoidovesical fistula is usually due to diverticulitis but may occur with carcinoma. History of pain on urination, frequency, burning and nocturia warn of adhesions to the bladder. When the fistula becomes established, the urine will become foul and a progressively severe cystitis develops. The passage of flatus on micturition is strong presumptive evidence that a colovesical fistula is present. There are no specific symptoms to indicate either an imminent or actual fistula into a neighboring bowel loop. The established fistula is usually uncovered by roentgenogram or by operation.[3]

In some cases of chronic or recurring diverticulitis considerable fibrosis of the bowel wall and narrowing of the lumen occur. These patients usually have recurrent bouts of abdominal pain, fever of varying degree and a change in bowel habits, usually toward progressive constipation. A mass may be palpable in the involved region and ultimately obstructive symptoms develop if the condition persists long enough. (Fig. 2.)

The diagnosis of diverticulitis is not always easy. Since the course of the disease may run the gamut from a single attack of acute diverticulitis to the various situations just described, it is readily apparent that the symptoms and physical and laboratory findings may vary. Therefore, it is well to make use of all the available diagnostic adjuncts.

Buie and Jackman[15] have stated that sigmoidoscopy is not only of distinct aid from a negative viewpoint but does afford definite contributory diagnostic assistance. They list five signs that are strongly suggestive of diverticulitis, namely, (1) limited mobility of a segment of bowel that is normally freely movable; (2) angulation of the bowel due to inflammation; (3) reduced lumen and adherent mucosal folds; the former is due to contracture of the fibrous tissue which has infiltrated the wall of the bowel; (4) sacculations of the sigmoid; these may appear as shallow pouches or depressions which may extend partially or completely around the wall of the bowel; (5) actual visualization of the openings of the diverticula through the sigmoidoscope. Of 242 patients with diverticula of the colon which they examined, they found one or more of the foregoing signs in 66 per cent. In thirty-five instances in this group they saw the diverticula.

The double contrast barium enema is the

most helpful aid in establishing the diagnosis. Although there is now only historical interest in any relationship between diverticulitis and cancer, the problem of making a differential diagnosis is far from a simple one. Schatzki[29] of the Massachusetts General Hospital states that a roentgenologic diagnosis between carcinoma and diverticulitis of the colon is easy in most cases, difficult in some and impossible in a few. In some instances it is impossible for the surgeon to make a definite diagnosis with the lesion in his hand.

Colovesical and enterocolic fistulas may be visualized by the passage of the opaque solution from the sigmoid into the adjacent loop of bowel or into the urinary bladder. The tracks are not always distinct, particularly in the entercolic variety. In the colovesical fistula, the more common of the two, the tract is more easily visualized by cystoscopy, cystography, using a dye as indigo carmine or methylene blue, and sigmoidoscopy.[3]

TREATMENT

It is the consensus that the treatment of uncomplicated acute diverticulitis should be non-surgical. Most of the patients with this condition respond well to medical management designed toward placing the inflamed part at rest. Bed rest should be emphasized until the patient becomes afebrile. A liquid diet is advisable with progression to bland, low residue feedings as the acute episode subsides. All fruits with seeds should be avoided, as should rough, raw or stringy vegetables.

Should constipation become troublesome, fruit juices may be taken in liberal quantities, in addition to mineral oil, administered in small doses in mid-morning to avoid interference with the absorption of fat-soluble vitamins. Irritative cathartics and colonic irrigations should be avoided at all times because of the danger of perforation. Hot saline rectal irrigations are of doubtful value. One may use a small saline enema or an oil retention enema when it is absolutely necessary to aid elimination.

We believe that administration of intestinal antiseptics such as sulfathaladine or sulfasuxidine is of merit. We prefer sulfathaladine in doses of 0.1 gm. per kg. of weight. Local heat by diathermy, heating pad or hot packs not only offers relief but also is of real value. Antispasmodics such as belladonna and its derivatives may be employed. The antibiotics, specifically penicillin and streptomycin, should be used in the more acute episodes of diverticulitis; however, they are generally not necessary in patients who will respond to medical measures.

Surgical intervention in diverticulitis should be reserved for its complications and those cases in which there is failure to respond under adequate medical therapy. The indications for operative treatment are as follows: (1) perforation with peritonitis; (2) abscess formation; (3) intestinal obstruction; (4) actual or impending formation of fistula; (5) chronic or recurring diverticulitis and (6) indistinguishability from cancer.

Acute perforation into the general peritoneal cavity warrants an emergency exploration in an attempt to locate and close the perforation. The abdominal cavity should be thoroughly aspirated and penicillin and streptomycin left *in situ*. If the actual opening cannot be located, a flap of omentum may be sutured over the area most likely to contain it. A Babcock metal sump drain or other suitable drain should be placed in the left lateral iliac gutter. In two instances we resigned ourselves to the more conservative measure of introducing a Babcock sump drain beside the perforated area. Both healed spontaneously. The simultaneous establishment of a transversostomy is advisable.

Abscess formation is by far the most common complication and should be treated with surgical drainage. Every attempt should be made to accomplish drainage without entering the free peritoneal cavity if possible. Any effort to exteriorize the involved segment of colon is not advisable.

Intestinal obstruction occurring with diverticulitis is most adequately treated with a transversostomy of the Devine or Wangensteen type to accomplish decompression and defunctionalize the involved segment of colon. Subsequent resection of the involved sigmoid may be undertaken after decompression is completed by resection and an end-to-end anastomosis. The interval between the two procedures is, of course, variable depending upon the condition of the patient, the inflammatory status of the involved segment of sigmoid and the rapidity with which the distal loop can be emptied and adequately prepared for surgery. In our experience a two-week period is usually adequate when obstruction occurs with peridiverticulitis. Should there be extensive inflammatory changes of the sigmoid, it is then advisable to postpone resection for a longer period to facilitate an easier procedure. (Figs. 3 and 4.)

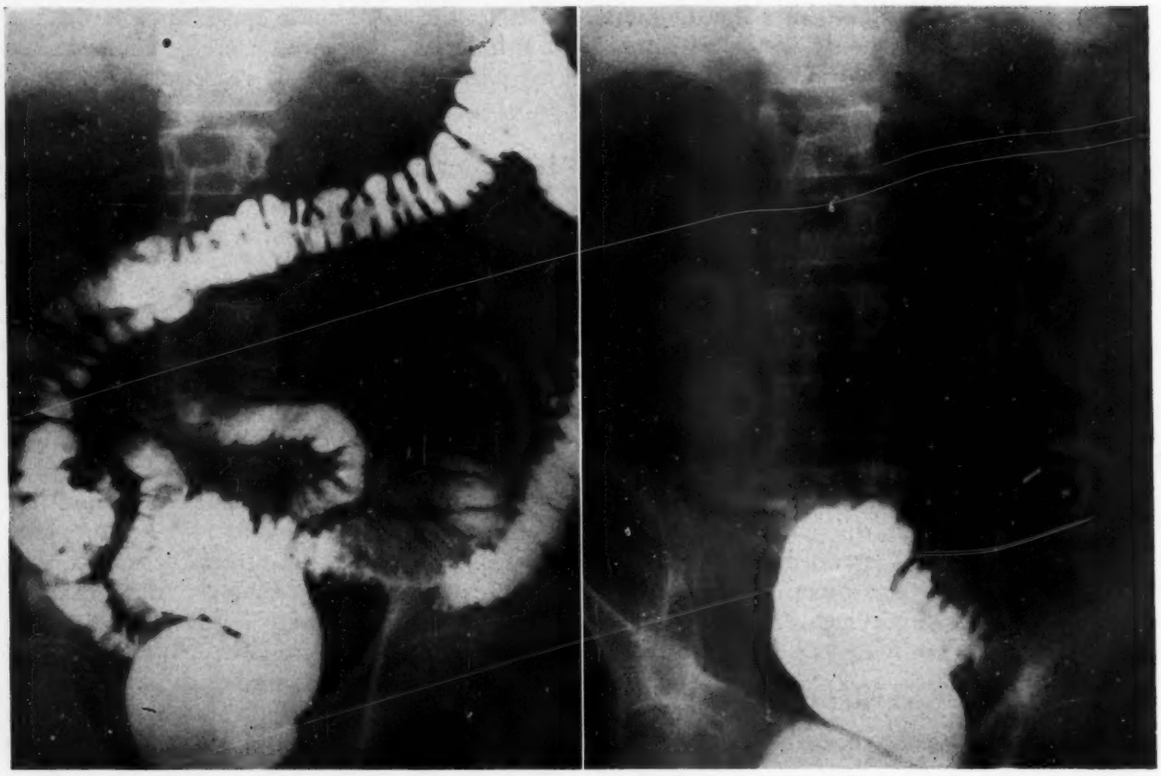

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FIG. 3. A, G. B., a fifty-five year old white male; x-ray confirmation of diverticulitis and peridiverticulitis; four episodes of disabling diverticulitis in next three years; surgery refused. B, same patient admitted to Temple University Hospital three years later with signs and symptoms of large bowel obstruction as indicated by retrograde barium and distention of colon with gas and feces; emergency transverse colostomy performed followed with resection of lesion and distal half of descending colon with an open end-to-end anastomosis three months later and subsequent closure of colostomy.

Sigmoidovesical fistulas are best treated with a preliminary diversionary type of transversostomy. Following this procedure the distal loop should be irrigated several times daily with a suspension of an intestinal antiseptic such as sulfathaladine. Catheter drainage of the bladder should be instituted preoperatively and intermittent irrigations carried out to clear up the usually existing cystitis. The interval between the colostomy and definitive operative procedure varies according to individual cases; however, emphasis should generally be placed on delaying the latter procedure for three to six months. At that time the bladder fistula is best resected via a partial cystectomy. If this is done, it is well to institute suprapubic bladder drainage along with a retention catheter. We have resected the involved segment of sigmoid in a few instances by abdominoperineal proctosigmoidectomy, and believe that this is a very rational procedure for this troublesome complication of diverticulitis.

Colovaginal fistulas may frequently be treated with a one-stage resection. However, it is unquestionably safer to precede resection with a diversionary colostomy in this instance, as with sigmoidovesical and abdominal wall fistulas. Enterocolic fistulas are most satisfactorily treated with staged procedures. An enteroenterostomy to divert the small bowel content from the sigmoid colon and a simultaneous transverse colostomy should be performed first. A subsequent resection of the involved segment of small bowel with end-to-end anastomosis and resection of the involved sigmoid can be accomplished during the second stage. Finally, the colostomy should be closed.

It has been the tendency in the past decade to treat as many phases of diverticulitis as possible using one-stage resections. This trend particularly includes chronic and recurring diverticulitis without obstruction and those cases that are indistinguishable from cancer. It is our belief that most of the complications of this disease, and particularly the patients with fistulas, should be treated with staged procedures initiated by a diversionary colostomy.

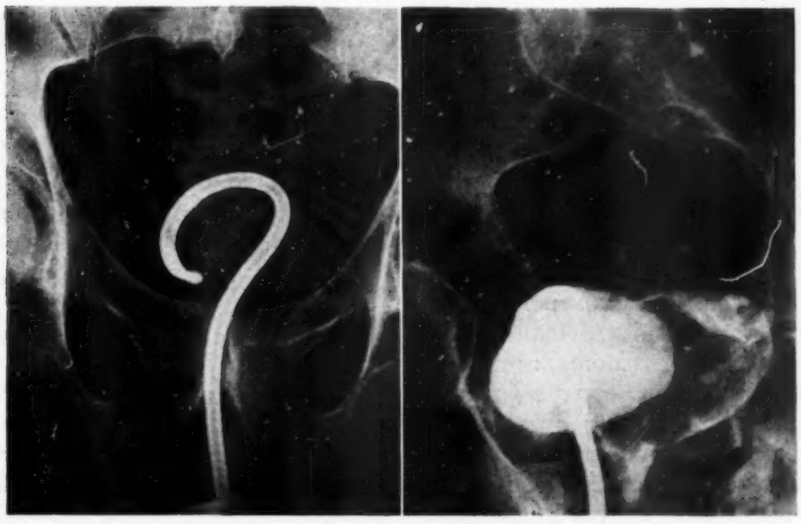

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FIG. 4. D. D., a fifty-eight year old white male; history and symptoms of diverticulitis three years prior to admission, confirmed by barium enema; abdominal distention, pain of left lower quadrant, dysuria and pneumaturia on this admission. A, catheter in bladder prior to cystogram with rectum and sigmoid free of opaque media. B, cystogram confirms diagnosis of sigmoido-vesical fistula; opaque media has entered sigmoid and rectum; a preliminary diversionary colostomy was performed, subsequent definitive surgery postponed by several episodes of nephrolithiasis.

Colostomy, *per se*, is now recognized as inadequate treatment for diverticulitis. In Pemberton's[25] series, in less than one-third of the cases satisfactory relief was achieved following closure of the colostomies. The inability to differentiate obstructive diverticulitis from carcinoma of the colon is a definite indication for operation. Laufman[16] believes that there is a 29 to 50 per cent error in diagnosis between carcinoma and diverticulitis. Pemberton and Black [25] reported a 25 per cent error in diagnosis in their series.

TABLE II
OPERATIVE CASES OF DIVERTICULITIS WITHOUT RESECTION

Operation	No. of Cases	Deaths	Percentage
Colostomy for obstruction	5	1	20
Incision and drainage of abscess	3	1	33⅓
Drainage for perforation without closure	2	0	0
Exploration only	2	0	0
Totals	12	2	16.6

In our group of 117 patients with diverticulitis, forty-one were subjected to operation. A palliative procedure was performed upon twelve (Table II) and resection upon twenty-nine patients (Table III). Of the twelve patients operated upon with no resection, there were two deaths, one following colostomy for obstruction and the second after incision and drainage for an abscess, with a mortality of 16.6 per cent.

Resection was carried out in twenty-nine instances, usually with some type of proximal colostomy prior to operation. Of the twenty-nine cases resected there was one death, which occurred as a result of peritonitis following resection with end-to-end anastomosis.

TABLE III
OPERATIVE CASES OF DIVERTICULITIS WITH RESECTION

Type of Resection	No. of Cases	Deaths	Percentage
Exteriorization (Mikulicz)	6	0	0
Abdominoperineal proctosigmoidectomy	4	0	0
Abdominoperineal proctosigmoidectomy with hemicolectomy	1	0	0
Primary end-to-end anastomosis	12	1	8.3
Anterior resection (excision) with colostomy and exteriorization of closed rectal stump (partial cystectomy in four)	6	0	0
Totals	29	1	3.4

SUMMARY

The various aspects of diverticulitis, based on a review of the literature and our clinical experience, have been presented. It is apparent that some phases of this disease entity are still controversial and warrant further investigation and follow-up studies. However, it is generally conceded that uncomplicated acute diverticulitis should be treated medically, while the complication of diverticulitis (e.g., perforation, abscess, obstruction and fistulas) demands surgical intervention. When carcinoma cannot be ruled out, resection of the involved segment is indicated. Chronic or recurring diverticulitis should be treated similarly in our estimation.

One hundred seventeen cases of sigmoidal diverticulitis were treated by the authors. Of this number forty-one were submitted to surgery. Resection was performed in twenty-nine cases with one death, a mortality rate of 3.4 per cent. Of the major surgery performed, six were by the exteriorization method of Mikulicz, four by abdominoperineal proctosigmoidectomy, one by abdominoperineal proctosigmoidectomy and hemicolectomy, and twelve by resection followed with end-to-end anastomosis. In six others sigmoidectomy with permanent colostomy and extraperitonealization of the closed rectal stump by the Hartman technic was instituted. Partial cystectomy was required in four instances. It is our opinion that prior to surgical intervention each patient must be carefully individualized, particularly in relation to the procedure best suited to his or her case.

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TREATMENT OF MAJOR TRIGEMINAL NEURALGIA THROUGH SECTION OF THE TRIGEMINOSPINAL TRACT IN THE MEDULLA

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SECTION of the trigeminospinal tract as a refinement of trigeminal nerve surgery for the treatment of tic douloureux introduced by Sjoquist[21,22] is well known. Although at first this procedure led to such postoperative complications as ataxia and dysarthria, Olivecrona[16] and Grant and Weinberger[9,10,30] succeeded in eliminating many of the distressing disturbances by doing the section at a lower level in the medulla.

In spite of the modifications it appears that the operation has not received the popular attention it rightfully deserves. When compared casually with posterior root section, recommended by Spiller and Frazier,[25] the necessary cerebellar approach for tract section may seem to be of greater surgical magnitude, considerably more time-consuming and, therefore, unjustifiable; whereas, root section can be performed more rapidly and gives satisfactory relief from pain.

The simplicity of root section in skilled hands was recently emphasized by Bucy,[3] an opinion which we heartily endorse. From the standpoint of safety the operation has few contraindications; however, this was not so in the beginning. In like manner, tractotomy can be reasonably expected to undergo such a metamorphosis. After root section certain complications which do occur, even though infrequent (e.g., facial paralysis, disturbing paresthesias, eye complications, disturbances of the muscles of mastication), stand as a challenge for a better operation.

After Sjoquist's[21,22] contribution on trigeminal tract section it became apparent that these distressing sequelae could be largely avoided, and the way was paved for a better approach to the problem. In 1938 Olivecrona,[16] after reviewing 313 cases of root section done in his clinic, recognized many undesirable features. He concluded that the results were not quite as brilliant as had been generally assumed. He then modified Sjoquist's trigeminal tract operation by placing the incision lower in the medulla and gained the following impressions: (1) The dangers of injury to the restiform body and vagal fibers were reduced. (2) Analgesia in the entire trigeminal area was possible (eighteen of the thirty cases reported obtained satisfactory analgesia). (3) Recurrence of attacks was common in cases of incomplete analgesia. Attacks of pain after tractotomy were reported in the cases of severe neuralgia even though analgesia was complete. It was Olivecrona's impression that such cases were not suitable for tractotomy, an impression apparently not universally held.

Grant and Weinberger, aware of the potentialities of tract section, in reporting their experiences[9,10] stated that it was too early to speak about dysesthesias with assurance. Subjective facial sensations occurred in five of their patients. They recommended the operation under the following circumstances: (1) in the case of severe neuralgia when the upper or all three divisions were involved; (2) in bilateral cases in which root section had been done on one side; (3) in neurotic persons who commonly developed distressing anesthesia when root section was done. They recognized that "burning pain" at times associated with tic douloureux was not relieved. Certain technical considerations and recommendations were made. Attention was called to the variation in size and shape of the medulla. A unilateral cerebellar approach with removal of the arch of the atlas was recommended. Precautionary measures against injuring the vertebral artery were emphasized. Low tractotomy avoided the restiform body and vagal fibers, which caused distressing symptoms by Sjoquist's original technique.[21] Finally, they stated the operation was not difficult.

Since patients suffering from major trigeminal neuralgia are on the average in the latter decades of life, it is evident that surgery of prolonged nature, entailing the risk of shock, is undesirable. Therefore, a simplified technic for

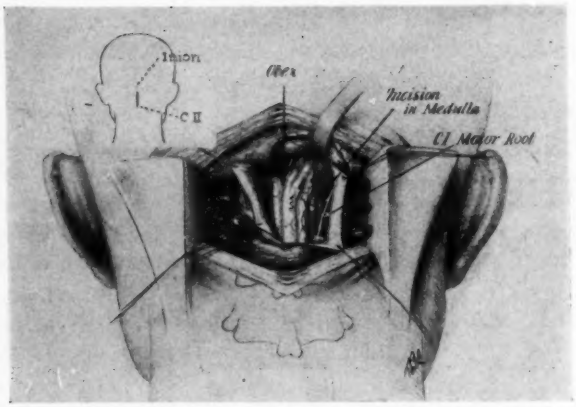


FIG. 1. View of the exposed medulla showing the obex, first cervical motor nerve root and anatomic location of tractotomy incision.

exposure appeared necessary permitting the operation to be done within a shorter period of time, thus reducing the hazard of a more prolonged procedure.

OPERATION

An appraisal of the situation led to a simplification of the standard midline cerebellar type of exposure. The incision is confined to the length required for exposure of the foramen magnum and the posterior arch of the atlas. Ample room is obtained by slightly enlarging the foramen magnum to the side of contemplated tractotomy and resecting the arch of the atlas. Adequate exposure of the medulla is then afforded by opening the dura mater through a linear incision curving at its upper extremity toward the side of the operation.

Here it should be further emphasized that lateral enlargement of the foramen magnum and arch of the atlas is important. It serves to give better exposure. Equally important, caution must be exercised during this step of the operation since the vertebral artery varies occasionally in its size and location and could be injured by carelessness.

The trigeminospinal tract is sectioned at a point slightly above the root of the first cervical nerve, 4 to 5 mm. in depth. We have gained the impression that the vagal rootlets and the calamus scriptorius above are not the best landmarks for tract section because of their anatomic variations. On the other hand, the first cervical nerve root and upper digitation of the denticulate ligament have served as an excellent guide. (Fig. 1.) The operation requires much less time than the usual posterior fossa exploratory craniotomy.

CLINICAL OBSERVATIONS

Our first experience with tractotomy was shortly after Sjoquist's original report. A man came to us after having had three unsuccessful operations elsewhere on his trigeminal root. He had severe neuralgia in all three divisions of the nerve and postoperative palsy of the sixth and seventh cranial nerves. Because of scar and disturbed anatomy from previous operations, section of the trigeminospinal tract appeared to be the operation of choice. It was therefore done and an excellent result was obtained. When subsequently applied to other cases of major trigeminal neuralgia, the results obtained proved so encouraging that with only rare exceptions we now employ tractotomy as a routine procedure.

Including these first encouraging results, section of the tract has been performed in fifty-nine instances. The oldest patient was eighty-one years, the youngest thirty-seven. One surgical fatality occurred from a pulmonary embolus. Asphyxia and cerebral anoxia from tongue swallowing occurred after operation in another before the patient revived from anesthesia. From the available literature we were able to collect seventy-one accounts of tractotomy for tic douloureux performed by various surgeons without a death. Sjoquist, twelve cases;[21–23] Kessel, one case;[14] Rowbotham, six;[17,18] Olivecrona, thirty-four;[34] Grant and associates, eleven;[8–11,23,29] Diez, one[5] and Brodal, two.[2]

Our fifty-nine cases added to these gives a total of 130 cases with one fatality as the result of operation (pulmonary embolus). In the case of cerebral asphyxia from tongue swallowing the patient never regained consciousness, developed convulsive seizures and eventually expired. While this death was not due to the operation and rightfully should be scored against nursing care, it has been included; this gives a surgical fatality of 1.54 per cent. If excluded the figures then show a 0.76 per cent mortality for tractotomy in tic douloureux. Additional cases not available to us have been reported.[6,7,12,24,31] Grant[11] in his latest report (1948) appears to have become pessimistic about tractotomy. He cited six cases, in five of which the patients had a recurrence of their tic pain. Complete analgesia was reported in the sixth case which had a satisfactory result. No mention was made, however, of the completeness of the operation in the five patients with

recurrence. Presumably, the entire tract had not been sectioned and analgesia was incomplete; otherwise a return of the neuralgia would not have occurred and a pessimistic regard for the operation would not have been gained. The price paid for relief by root section was emphasized. Only 62 per cent of patients were completely satisfied with the result. In probably an unparalleled experience an enviable mortality record of 1.85 per cent was achieved.

In spite of the overwhelming data on root section we presently believe that tractotomy is the more desirable of the two operations since it eliminates the undesirable features of root section. Even though the number of patients subjected to tractotomy is still small, the mortality figure is, likewise, small.

Our experience with bilateral tractotomy has been limited to one sixty-seven year old patient. She had suffered repeated bilateral trigeminal attacks for several years. Alcohol injection had been limited to the maxillary divisions because of possible motor fifth consequences of bilateral mandibular injection. Bilateral tractotomy was performed, analgesia of both trigeminal zones was obtained and convalescence was uneventful. Olivecrona reported three similar cases,[16] in all of which the patients enjoyed an uncomplicated postoperative course. We are not aware of other reports on bilateral tractotomy for trigeminal neuralgia. Crawford,[4] however, in 1947 reported two cases of bilateral tractotomy of the lateral spinothalamic tract in the medulla for intractable pain, with one death attributed to injury of the vagal nuclei. Pyramidal tract injury which apparently cleared after a few weeks was reported in other unilateral cases. Certainly the dorsolateral position of the trigeminal tract eliminates for practical purposes such complications in tractotomy for tic douloureux.

One has to see only once bilateral paralysis of the motor fifth and seventh cranial nerves after bilateral root section to develop a genuine fear of such a consequence. Although this surgical disaster did not happen to us, we had the miserable experience of seeing one such example. Of all the reported complications from tractotomy aggregated, they could hardly equal such a disfiguring anatomic catastrophe. Fortunately judgment usually prevails over courage, and such one-stage sessions are undoubtedly rare. Even though we had only one experience with bilateral tractotomy, we believe it may well

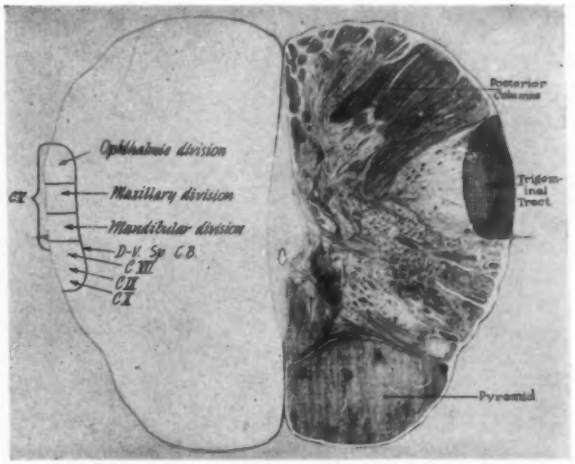


FIG. 2. Shaded area on right shows suggested arrangement of trigeminal fibers in the medulla. This impression was gained from three of our own experiences and an experience by Schwartz and O'Leary; left, possible arrangement of sensory tracts of other cranial nerves.

be the operation of choice in bilateral tic douloureux.

The arrangement of the fibers in the trigeminospinal tract at the level of section appears, from our observations, to begin with the ophthalmic division adjacent to the dorsolateral sulcus, the maxillary and mandibular fibers, in order, occupying an adjacent anterior position, with probably seventh, ninth and tenth cranial nerve representation in order anteriorly. (Fig. 2.) These observations differ from those of Grant, et al.[8] Weinberger and Grant,[29] and earlier reports by Bergman,[1] Spiller and Frazier,[25] Wallenberg,[28] and Kutner and Kramer.[15] Their data indicate that the ophthalmic division occupies the ventral part of the spinal trigeminal tract.

On the other hand, Schwartz and O'Leary[20] showed conclusively that the mandibular division was situated ventrally in their case. They were able to study their patient before and after operation. The autopsy specimen was obtained some time later, and they verified the incision in the ventral portion of the spinal trigeminal tract. Before the patient died the mandibular trigeminal zone had been rendered analgesic by the operation. Our impressions were gained from three patients. After the first operation upon each patient analgesia was noted in the ophthalmic and a portion of the maxillary division only. The incision in these patients had been carried from the dorsolateral sulcus anteriorly. At the time of their second operations

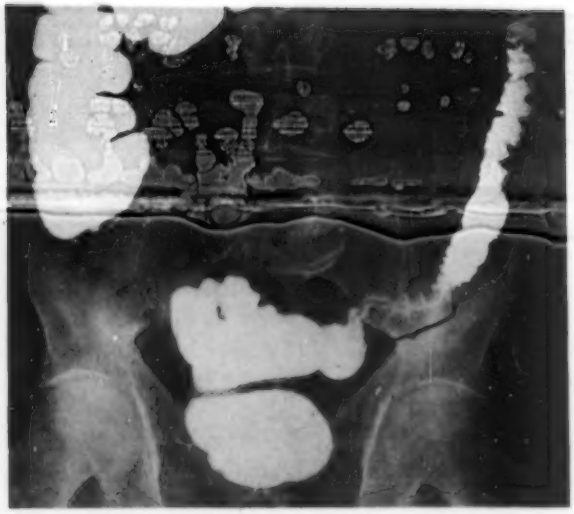


FIG. 2. G. R., aged sixty-one; barium enema reported diverticula and an inconstant defect of the sigmoid. Resection verified diverticulitis and peridiverticulitis with stricture formation.

When perforation has occurred, signs of peritonitis such as cramping lower abdominal pain usually are present and are associated with fever, chills and abdominal tenderness. If the process becomes localized and an abscess forms, a mass may soon become palpable in the lower abdomen and the febrile course will persist. Perforation and extension into the psoas muscle may occur in some instances. Here an abscess may not be palpable, but severe low back pain radiating down the anterior thigh may be the chief symptom. We are all aware of the frequent diagnostic confusion which arises in cases of women in whom so often a pelvic mass is mistaken for disease of the adenexa. Particularly is this more likely to occur when there are minimal symptoms of bowel dysfunction.

TABLE 1

Symptoms	No. of Cases	Percentage
Pain (abdominal)	98	83.7
Constipation	80	68.3
Diarrhea	13	11.1
Constipation alternating with diarrhea	15	12.7
Bleeding	21	18.0
Palpable mass in sigmoid (noted by patient)	23	19.6
Pneumaturia	19	16.3

Perforation of an abscess or an inflamed sigmoidovesical fistula is usually due to diverticulitis but may occur with carcinoma. History of pain on urination, frequency, burning and nocturia warn of adhesions to the bladder. When the fistula becomes established, the urine will become foul and a progressively severe cystitis develops. The passage of flatus on micturition is strong presumptive evidence that a colovesical fistula is present. There are no specific symptoms to indicate either an imminent or actual fistula into a neighboring bowel loop. The established fistula is usually uncovered by roentgenogram or by operation.[3]

In some cases of chronic or recurring diverticulitis considerable fibrosis of the bowel wall and narrowing of the lumen occur. These patients usually have recurrent bouts of abdominal pain, fever of varying degree and a change in bowel habits, usually toward progressive constipation. A mass may be palpable in the involved region and ultimately obstructive symptoms develop if the condition persists long enough. (Fig. 2.)

The diagnosis of diverticulitis is not always easy. Since the course of the disease may run the gamut from a single attack of acute diverticulitis to the various situations just described, it is readily apparent that the symptoms and physical and laboratory findings may vary. Therefore, it is well to make use of all the available diagnostic adjuncts.

Buie and Jackman[15] have stated that sigmoidoscopy is not only of distinct aid from a negative viewpoint but does afford definite contributory diagnostic assistance. They list five signs that are strongly suggestive of diverticulitis, namely, (1) limited mobility of a segment of bowel that is normally freely movable; (2) angulation of the bowel due to inflammation; (3) reduced lumen and adherent mucosal folds; the former is due to contracture of the fibrous tissue which has infiltrated the wall of the bowel; (4) sacculations of the sigmoid; these may appear as shallow pouches or depressions which may extend partially or completely around the wall of the bowel; (5) actual visualization of the openings of the diverticula through the sigmoidoscope. Of 242 patients with diverticula of the colon which they examined, they found one or more of the foregoing signs in 66 per cent. In thirty-five instances in this group they saw the diverticula.

The double contrast barium enema is the

cancer, the problem of making a differential diagnosis is far from a simple one. Schatzki[29] of the Massachusetts General Hospital states that a roentgenologic diagnosis between carcinoma and diverticulitis of the colon is easy in most cases, difficult in some and impossible in a few. In some instances it is impossible for the surgeon to make a definite diagnosis with the lesion in his hand.

Colovesical and enterocolic fistulas may be visualized by the passage of the opaque solution from the sigmoid into the adjacent loop of bowel or into the urinary bladder. The tracks are not always distinct, particularly in the entercolic variety. In the colovesical fistula, the more common of the two, the tract is more easily visualized by cystoscopy, cystography, using a dye as indigo carmine or methylene blue, and sigmoidoscopy.[3]

TREATMENT

It is the consensus that the treatment of uncomplicated acute diverticulitis should be non-surgical. Most of the patients with this condition respond well to medical management designed toward placing the inflamed part at rest. Bed rest should be emphasized until the patient becomes afebrile. A liquid diet is advisable with progression to bland, low residue feedings as the acute episode subsides. All fruits with seeds should be avoided, as should rough, raw or stringy vegetables.

Should constipation become troublesome, fruit juices may be taken in liberal quantities, in addition to mineral oil, administered in small doses in mid-morning to avoid interference with the absorption of fat-soluble vitamins. Irritative cathartics and colonic irrigations should be avoided at all times because of the danger of perforation. Hot saline rectal irrigations are of doubtful value. One may use a small saline enema or an oil retention enema when it is absolutely necessary to aid elimination.

We believe that administration of intestinal antiseptics such as sulfathaladine or sulfasuxidine is of merit. We prefer sulfathaladine in doses of 0.1 gm. per kg. of weight. Local heat by diathermy, heating pad or hot packs not only offers relief but also is of real value. Antispasmodics such as belladonna and its derivatives may be employed. The antibiotics, specifically penicillin and streptomycin, should be

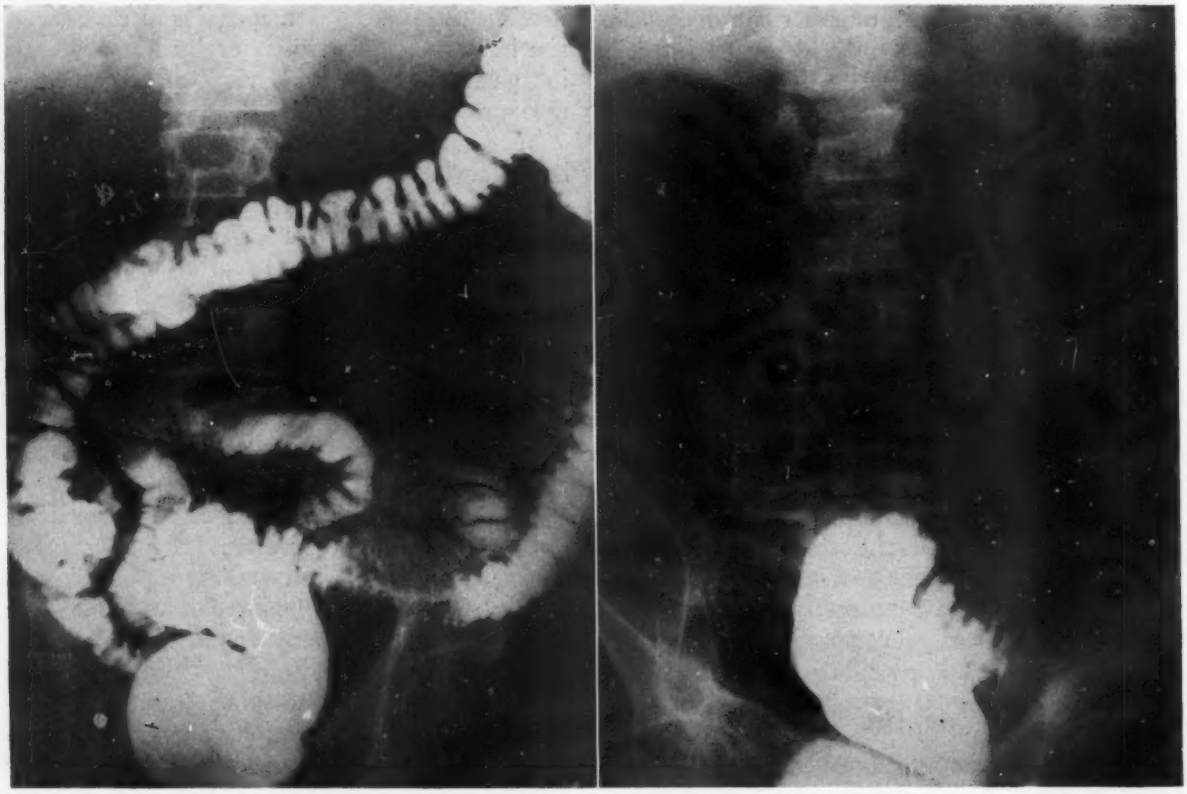
measures.

Surgical intervention in diverticulitis should be reserved for its complications and those cases in which there is failure to respond under adequate medical therapy. The indications for operative treatment are as follows: (1) perforation with peritonitis; (2) abscess formation; (3) intestinal obstruction; (4) actual or impending formation of fistula; (5) chronic or recurring diverticulitis and (6) indistinguishability from cancer.

Acute perforation into the general peritoneal cavity warrants an emergency exploration in an attempt to locate and close the perforation. The abdominal cavity should be thoroughly aspirated and penicillin and streptomycin left *in situ*. If the actual opening cannot be located, a flap of omentum may be sutured over the area most likely to contain it. A Babcock metal sump drain or other suitable drain should be placed in the left lateral iliac gutter. In two instances we resigned ourselves to the more conservative measure of introducing a Babcock sump drain beside the perforated area. Both healed spontaneously. The simultaneous establishment of a transversostomy is advisable.

Abscess formation is by far the most common complication and should be treated with surgical drainage. Every attempt should be made to accomplish drainage without entering the free peritoneal cavity if possible. Any effort to exteriorize the involved segment of colon is not advisable.

Intestinal obstruction occurring with diverticulitis is most adequately treated with a transversostomy of the Devine or Wangensteen type to accomplish decompression and defunctionalize the involved segment of colon. Subsequent resection of the involved sigmoid may be undertaken after decompression is completed by resection and an end-to-end anastomosis. The interval between the two procedures is, of course, variable depending upon the condition of the patient, the inflammatory status of the involved segment of sigmoid and the rapidity with which the distal loop can be emptied and adequately prepared for surgery. In our experience a two-week period is usually adequate when obstruction occurs with peridiverticulitis. Should there be extensive inflammatory changes of the sigmoid, it is then advisable to postpone resection for a longer period to facilitate an easier procedure. (Figs. 3 and 4.)



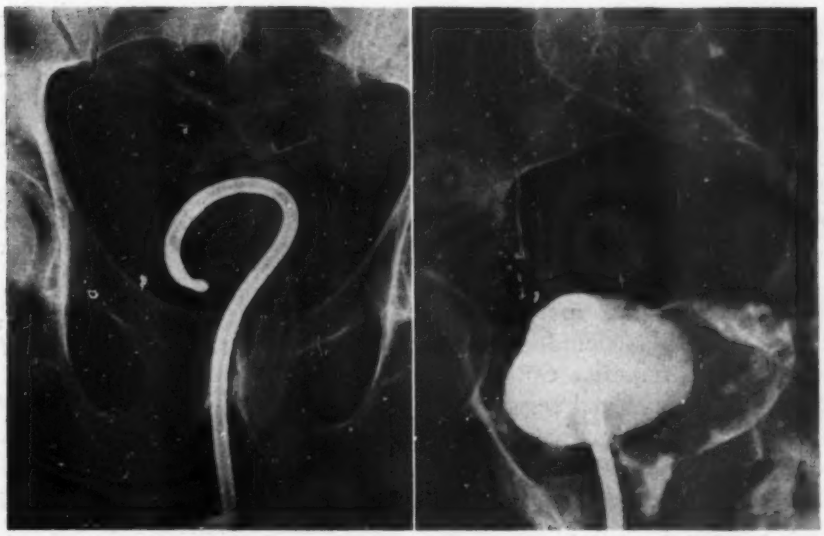
3A 3B

FIG. 3. A, G. B., a fifty-five year old white male; x-ray confirmation of diverticulitis and peridiverticulitis; four episodes of disabling diverticulitis in next three years; surgery refused. B, same patient admitted to Temple University Hospital three years later with signs and symptoms of large bowel obstruction as indicated by retrograde barium and distention of colon with gas and feces; emergency transverse colostomy performed followed with resection of lesion and distal half of descending colon with an open end-to-end anastomosis three months later and subsequent closure of colostomy.

Sigmoidovesical fistulas are best treated with a preliminary diversionary type of transversostomy. Following this procedure the distal loop should be irrigated several times daily with a suspension of an intestinal antiseptic such as sulfathaladine. Catheter drainage of the bladder should be instituted preoperatively and intermittent irrigations carried out to clear up the usually existing cystitis. The interval between the colostomy and definitive operative procedure varies according to individual cases; however, emphasis should generally be placed on delaying the latter procedure for three to six months. At that time the bladder fistula is best resected via a partial cystectomy. If this is done, it is well to institute suprapubic bladder drainage along with a retention catheter. We have resected the involved segment of sigmoid in a few instances by abdominoperineal proctosigmoidectomy, and believe that this is a very rational procedure for this troublesome complication of diverticulitis.

Colovaginal fistulas may frequently be treated with a one-stage resection. However, it is unquestionably safer to precede resection with a diversionary colostomy in this instance, as with sigmoidovesical and abdominal wall fistulas. Enterocolic fistulas are most satisfactorily treated with staged procedures. An enteroenterostomy to divert the small bowel content from the sigmoid colon and a simultaneous transverse colostomy should be performed first. A subsequent resection of the involved segment of small bowel with end-to-end anastomosis and resection of the involved sigmoid can be accomplished during the second stage. Finally, the colostomy should be closed.

It has been the tendency in the past decade to treat as many phases of diverticulitis as possible using one-stage resections. This trend particularly includes chronic and recurring diverticulitis without obstruction and those cases that are indistinguishable from cancer. It is our belief that most of the complications of this disease, and particularly the patients with fistulas, should be treated with staged procedures initiated by a diversionary colostomy.



4A 4B

FIG. 4. D. D., a fifty-eight year old white male; history and symptoms of diverticulitis three years prior to admission, confirmed by barium enema; abdominal distention, pain of left lower quadrant, dysuria and pneumaturia on this admission. A, catheter in bladder prior to cystogram with rectum and sigmoid free of opaque media. B, cystogram confirms diagnosis of sigmoido-vesical fistula; opaque media has entered sigmoid and rectum; a preliminary diversionary colostomy was performed, subsequent definitive surgery postponed by several episodes of nephrolithiasis.

Colostomy, *per se*, is now recognized as inadequate treatment for diverticulitis. In Pemberton's[25] series, in less than one-third of the cases satisfactory relief was achieved following closure of the colostomies. The inability to differentiate obstructive diverticulitis from carcinoma of the colon is a definite indication for operation. Laufman[16] believes that there is a 29 to 50 per cent error in diagnosis between carcinoma and diverticulitis. Pemberton and Black [25] reported a 25 per cent error in diagnosis in their series.

TABLE II
OPERATIVE CASES OF DIVERTICULITIS WITHOUT RESECTION

Operation	No. of Cases	Deaths	Percentage
Colostomy for obstruction	5	1	20
Incision and drainage of abscess	3	1	33⅓
Drainage for perforation without closure	2	0	0
Exploration only	2	0	0
Totals	12	2	16.6

In our group of 117 patients with diverticulitis, forty-one were subjected to operation. A palliative procedure was performed upon twelve (Table II) and resection upon twenty-nine patients (Table III). Of the twelve patients operated upon with no resection, there were two deaths, one following colostomy for obstruction and the second after incision and drainage for an abscess, with a mortality of 16.6 per cent.

Resection was carried out in twenty-nine instances, usually with some type of proximal colostomy prior to operation. Of the twenty-nine cases resected there was one death, which occurred as a result of peritonitis following resection with end-to-end anastomosis.

TABLE III
OPERATIVE CASES OF DIVERTICULITIS WITH RESECTION

Type of Resection	No. of Cases	Deaths	Percentage
Exteriorization (Mikulicz)	6	0	0
Abdominoperineal proctosigmoidectomy	4	0	0
Abdominoperineal proctosigmoidectomy with hemicolectomy	1	0	0
Primary end-to-end anastomosis	12	1	8.3
Anterior resection (excision) with colostomy and exteriorization of closed rectal stump (partial cystectomy in four)	6	0	0
Totals	29	1	3.4

SUMMARY

The various aspects of diverticulitis, based on a review of the literature and our clinical experience, have been presented. It is apparent that some phases of this disease entity are still controversial and warrant further investigation and follow-up studies. However, it is generally conceded that uncomplicated acute diverticulitis should be treated medically, while the complication of diverticulitis (e.g., perforation, abscess, obstruction and fistulas) demands surgical intervention. When carcinoma cannot be ruled out, resection of the involved segment is indicated. Chronic or recurring diverticulitis should be treated similarly in our estimation.

One hundred seventeen cases of sigmoidal diverticulitis were treated by the authors. Of this number forty-one were submitted to surgery. Resection was performed in twenty-nine cases with one death, a mortality rate of 3.4 per cent. Of the major surgery performed, six were by the exteriorization method of Mikulicz, four by abdominoperineal proctosigmoidectomy, one by abdominoperineal proctosigmoidectomy and hemicolectomy, and twelve by resection followed with end-to-end anastomosis. In six others sigmoidectomy with permanent colostomy and extraperitonealization of the closed rectal stump by the Hartman technic was instituted. Partial cystectomy was required in four instances. It is our opinion that prior to surgical intervention each patient must be carefully individualized, particularly in relation to the procedure best suited to his or her case.

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TREATMENT OF MAJOR TRIGEMINAL NEURALGIA THROUGH SECTION OF THE TRIGEMINOSPINAL TRACT IN THE MEDULLA

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SECTION of the trigeminospinal tract as a refinement of trigeminal nerve surgery for the treatment of tic douloureux introduced by Sjoquist[21,22] is well known. Although at first this procedure led to such postoperative complications as ataxia and dysarthria, Olivecrona[16] and Grant and Weinberger[9,10,30] succeeded in eliminating many of the distressing disturbances by doing the section at a lower level in the medulla.

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SUMMARY

The various aspects of diverticulitis, based on a review of the literature and our clinical experience, have been presented. It is apparent that some phases of this disease entity are still controversial and warrant further investigation and follow-up studies. However, it is generally conceded that uncomplicated acute diverticulitis should be treated medically, while the complication of diverticulitis (e.g., perforation, abscess, obstruction and fistulas) demands surgical intervention. When carcinoma cannot be ruled out, resection of the involved segment is indicated. Chronic or recurring diverticulitis should be treated similarly in our estimation.

One hundred seventeen cases of sigmoidal diverticulitis were treated by the authors. Of this number forty-one were submitted to surgery. Resection was performed in twenty-nine cases with one death, a mortality rate of 3.4 per cent. Of the major surgery performed, six were by the exteriorization method of Mikulicz, four by abdominoperineal proctosigmoidectomy, one by abdominoperineal proctosigmoidectomy and hemicolectomy, and twelve by resection followed with end-to-end anastomosis. In six others sigmoidectomy with permanent colostomy and extraperitonealization of the closed rectal stump by the Hartman technic was instituted. Partial cystectomy was required in four instances. It is our opinion that prior to surgical intervention each patient must be carefully individualized, particularly in relation to the procedure best suited to his or her case.

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TREATMENT OF MAJOR TRIGEMINAL NEURALGIA THROUGH SECTION OF THE TRIGEMINOSPINAL TRACT IN THE MEDULLA

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SECTION of the trigeminospinal tract as a refinement of trigeminal nerve surgery for the treatment of tic douloureux introduced by Sjoquist[21,22] is well known. Although at first this procedure led to such postoperative complications as ataxia and dysarthria, Olivecrona[16] and Grant and Weinberger[9,10,30] succeeded in eliminating many of the distressing disturbances by doing the section at a lower level in the medulla.

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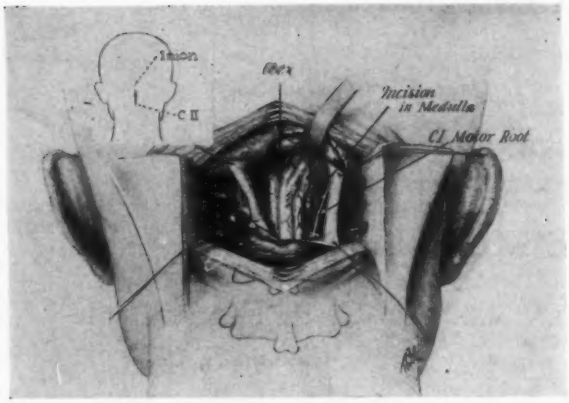

FIG. 1. View of the exposed medulla showing the obex, first cervical motor nerve root and anatomic location of tractotomy incision.

exposure appeared necessary permitting the operation to be done within a shorter period of time, thus reducing the hazard of a more prolonged procedure.

OPERATION

An appraisal of the situation led to a simplification of the standard midline cerebellar type of exposure. The incision is confined to the length required for exposure of the foramen magnum and the posterior arch of the atlas. Ample room is obtained by slightly enlarging the foramen magnum to the side of contemplated tractotomy and resecting the arch of the atlas. Adequate exposure of the medulla is then afforded by opening the dura mater through a linear incision curving at its upper extremity toward the side of the operation.

Here it should be further emphasized that lateral enlargement of the foramen magnum and arch of the atlas is important. It serves to give better exposure. Equally important, caution must be exercised during this step of the operation since the vertebral artery varies occasionally in its size and location and could be injured by carelessness.

The trigeminospinal tract is sectioned at a point slightly above the root of the first cervical nerve, 4 to 5 mm. in depth. We have gained the impression that the vagal rootlets and the calamus scriptorius above are not the best landmarks for tract section because of their anatomic variations. On the other hand, the first cervical nerve root and upper digitation of the denticulate ligament have served as an excellent guide. (Fig. 1.) The operation requires much less time than the usual posterior fossa exploratory craniotomy.

CLINICAL OBSERVATIONS

Our first experience with tractotomy was shortly after Sjoquist's original report. A man came to us after having had three unsuccessful operations elsewhere on his trigeminal root. He had severe neuralgia in all three divisions of the nerve and postoperative palsy of the sixth and seventh cranial nerves. Because of scar and disturbed anatomy from previous operations, section of the trigeminospinal tract appeared to be the operation of choice. It was therefore done and an excellent result was obtained. When subsequently applied to other cases of major trigeminal neuralgia, the results obtained proved so encouraging that with only rare exceptions we now employ tractotomy as a routine procedure.

Including these first encouraging results, section of the tract has been performed in fifty-nine instances. The oldest patient was eighty-one years, the youngest thirty-seven. One surgical fatality occurred from a pulmonary embolus. Asphyxia and cerebral anoxia from tongue swallowing occurred after operation in another before the patient revived from anesthesia. From the available literature we were able to collect seventy-one accounts of tractotomy for tic douloureux performed by various surgeons without a death. Sjoquist, twelve cases;[21–23] Kessel, one case;[14] Rowbotham, six;[17,18] Olivecrona, thirty-four;[34] Grant and associates, eleven;[8–11,23,29] Diez, one[5] and Brodal, two.[2]

Our fifty-nine cases added to these gives a total of 130 cases with one fatality as the result of operation (pulmonary embolus). In the case of cerebral asphyxia from tongue swallowing the patient never regained consciousness, developed convulsive seizures and eventually expired. While this death was not due to the operation and rightfully should be scored against nursing care, it has been included; this gives a surgical fatality of 1.54 per cent. If excluded the figures then show a 0.76 per cent mortality for tractotomy in tic douloureux. Additional cases not available to us have been reported.[6,7,12,24,31] Grant[11] in his latest report (1948) appears to have become pessimistic about tractotomy. He cited six cases, in five of which the patients had a recurrence of their tic pain. Complete analgesia was reported in the sixth case which had a satisfactory result. No mention was made, however, of the completeness of the operation in the five patients with

recurrence. Presumably, the entire tract had not been sectioned and analgesia was incomplete; otherwise a return of the neuralgia would not have occurred and a pessimistic regard for the operation would not have been gained. The price paid for relief by root section was emphasized. Only 62 per cent of patients were completely satisfied with the result. In probably an unparalleled experience an enviable mortality record of 1.85 per cent was achieved.

In spite of the overwhelming data on root section we presently believe that tractotomy is the more desirable of the two operations since it eliminates the undesirable features of root section. Even though the number of patients subjected to tractotomy is still small, the mortality figure is, likewise, small.

Our experience with bilateral tractotomy has been limited to one sixty-seven year old patient. She had suffered repeated bilateral trigeminal attacks for several years. Alcohol injection had been limited to the maxillary divisions because of possible motor fifth consequences of bilateral mandibular injection. Bilateral tractotomy was performed, analgesia of both trigeminal zones was obtained and convalescence was uneventful. Olivecrona reported three similar cases,[16] in all of which the patients enjoyed an uncomplicated postoperative course. We are not aware of other reports on bilateral tractotomy for trigeminal neuralgia. Crawford,[4] however, in 1947 reported two cases of bilateral tractotomy of the lateral spinothalamic tract in the medulla for intractable pain, with one death attributed to injury of the vagal nuclei. Pyramidal tract injury which apparently cleared after a few weeks was reported in other unilateral cases. Certainly the dorsolateral position of the trigeminal tract eliminates for practical purposes such complications in tractotomy for tic douloureux.

One has to see only once bilateral paralysis of the motor fifth and seventh cranial nerves after bilateral root section to develop a genuine fear of such a consequence. Although this surgical disaster did not happen to us, we had the miserable experience of seeing one such example. Of all the reported complications from tractotomy aggregated, they could hardly equal such a disfiguring anatomic catastrophe. Fortunately judgment usually prevails over courage, and such one-stage sessions are undoubtedly rare. Even though we had only one experience with bilateral tractotomy, we believe it may well be the operation of choice in bilateral tic douloureux.

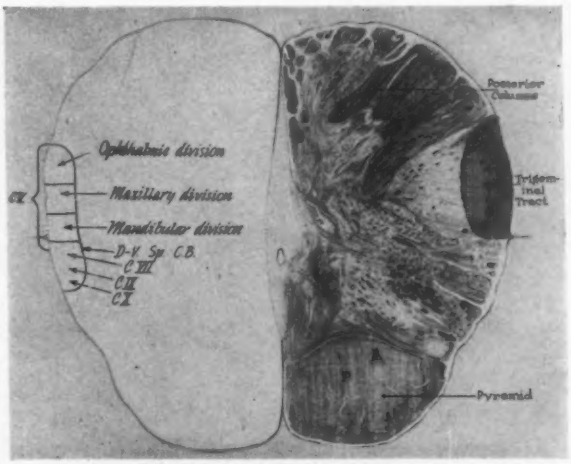

FIG. 2. Shaded area on right shows suggested arrangement of trigeminal fibers in the medulla. This impression was gained from three of our own experiences and an experience by Schwartz and O'Leary; left, possible arrangement of sensory tracts of other cranial nerves.

The arrangement of the fibers in the trigeminospinal tract at the level of section appears, from our observations, to begin with the ophthalmic division adjacent to the dorsolateral sulcus, the maxillary and mandibular fibers, in order, occupying an adjacent anterior position, with probably seventh, ninth and tenth cranial nerve representation in order anteriorly. (Fig. 2.) These observations differ from those of Grant, et al.[8] Weinberger and Grant,[29] and earlier reports by Bergman,[1] Spiller and Frazier,[25] Wallenberg,[28] and Kutner and Kramer.[15] Their data indicate that the ophthalmic division occupies the ventral part of the spinal trigeminal tract.

On the other hand, Schwartz and O'Leary[20] showed conclusively that the mandibular division was situated ventrally in their case. They were able to study their patient before and after operation. The autopsy specimen was obtained some time later, and they verified the incision in the ventral portion of the spinal trigeminal tract. Before the patient died the mandibular trigeminal zone had been rendered analgesic by the operation. Our impressions were gained from three patients. After the first operation upon each patient analgesia was noted in the ophthalmic and a portion of the maxillary division only. The incision in these patients had been carried from the dorsolateral sulcus anteriorly. At the time of their second operations

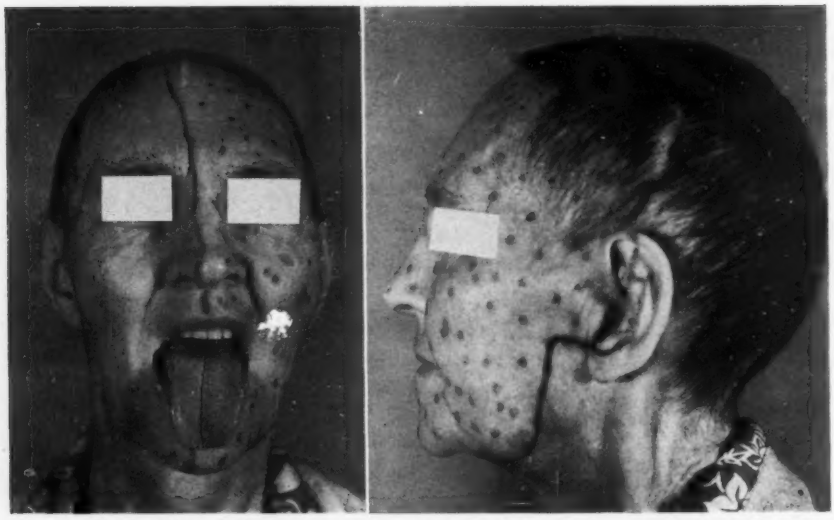

FIG. 3. Stippled area indicates zone of analgesia and thermesthesia following tractotomy; also, zone of slightly impaired touch sensation. Other modalities of sensation are intact.

a few days after the first, the incision was carried farther anteriorly. Analgesia then was obtained in the remainder of the maxillary and the mandibular division, the external auditory canal, tympanic membrane, soft palate and tonsillar area. The lateral spinothalamic tract was partially involved in three patients. In one the leg below the knee opposite the tractotomy showed spotty impairment of pain and temperature sensibilities. The other two patients had contralateral analgesia to the mid-thoracic region. This sensory loss was not a source of complaint or disability.

Postoperative disturbances were of an extremely mild and transitory character comparable in many ways to those reported by Grant and Weinberger and others. The distressing complications of protracted ataxia, which is quite frequently encountered after surgery using Sjoquist's technic, did not occur and injury to the vagal fibers was avoided. Although herpetic eruptions, which often appear after posterior root section, did appear at times, they were never of comparable violence.

Since Walker[26,27] has shown that touch fibers are present in the descending trigeminal tract and Weinberger[8–10,29] and Grant verified the finding, it is not at all surprising to find patients aware of some difference in touch sensations on the operated side. Our patients on interrogation admitted a slightly different (impaired) sensation to touch on the operated side, but in no instance was it volunteered as a complaint. (Fig. 3.)

A marked postoperative anxiety reaction developed in nine cases. Fearful of returning seizures, these patients were convinced that severe paroxysms of pain had actually occurred. They complained of drafts and protected their faces from stimulation which had brought on attacks prior to operation. It took several days before they finally recognized that these sensations were in reality faulty interpretations from the effects of drugs. Unlike real attacks, these patients usually awakened suddenly from drug-induced sleep thinking that an attack had actually occurred. In this group of patients stimulation of the trigger areas in spite of analgesia produced sudden touch sensations equivalent to the painful preoperative attacks; however, no pain occurred. These equivalents have persisted in four patients but are no longer of concern to them.

One woman complained of pain after tractotomy. Her analgesia was not complete. Further section was done and complete analgesia was obtained. She still complained of pain in her face but was much improved. She had been addicted to narcotics and required, as these people do, considerable quantities of the drug even after complete analgesia was obtained. She was discharged considerably improved, with complete analgesia in her face and hypalgesia and thermalgesia in the contralateral side of the body to the third dorsal level. When heard from a year later she had had an alcohol injection in the mandibular division elsewhere but still complained of pain. She also volunteered that her

thermalgesia and hypalgesia in the contralateral side of the body were still present. An opportunity to check her for complete analgesia in the face has not presented itself. Even though this patient was addicted to narcotics and the diagnosis might possibly be questioned, she was classified as having tic douloureux continuing after tractotomy.

Speech disturbance was observed in another patient. Tractotomy was done at a slightly higher level in this instance because of an arterial plexus overlying the usual site of incision. Three days after surgery hoarseness and ataxia developed, which we believe was caused from regional arterial thrombosis. The husky quality of the voice remained permanently, however, without proving distressing to the patient. Regurgitation of fluids also occurred for a few days and then disappeared. The ataxia ceased to be troublesome after eight months. Of interest, one year later she again complained of pain and used the same descriptive terms that she had previously used in describing her attacks of tic douloureux. The only difference volunteered this time was that the pain was continuous and in the maxillary and retro-orbital regions. Efforts on our part were made to arrest her fears by pointing out that pain could not return to her face in the analgesic zone. Needless to say, they were neither convincing to her nor satisfactory to us. Posterior root section was then unwisely done. It, of course, failed to give relief and left her with painful anesthesia. This was one of our earlier cases. A later and more intelligent history revealed that she had been a sufferer of chronic headache for many years before the onset of tic douloureux; further, her present discomfort was actually bilateral but focused primarily to the operated side. Roentgen ray studies showed an old degenerated cervical disc lesion. (Fig. 4.) Examination of the neck revealed the usual physical signs of cervical and suboccipital tenderness to pressure, which increased the face pain; traction therapy gave prompt relief. After relief of pain by traction she was reasonably convinced as to the source of her trouble but occasionally called about minor discomfort. At these times she was hopeful that the discomfort was a possible indication that sensation in the face was returning as it had after alcohol injections. She invariably refused treatment subsequently, stating that the discomfort did not interfere with her activity or sleep.

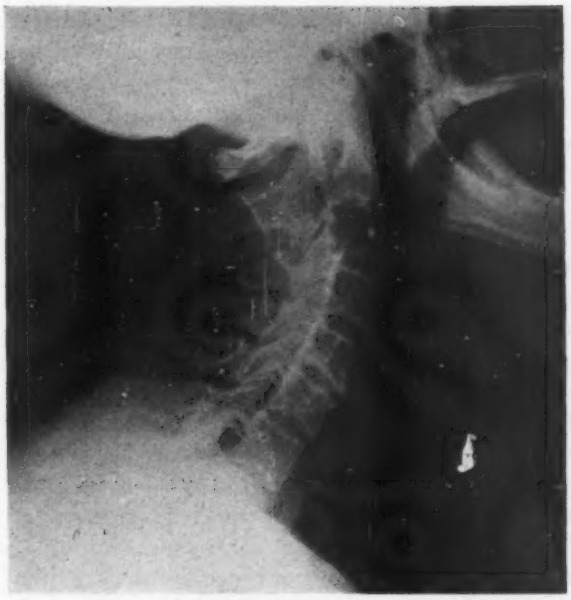

FIG. 4. Roentgenogram showing evidence of old, chronic, degenerated cervical disc lesion, with segmental flattening of the cervical curve.

Since we believe that many of the face pains of so-called atypical facial neuralgia, usually difficult to localize sharply, have their origin in the neck from cervical disc degeneration, we have come to inquire into the past of all discomforts related to the head or neck in patients suffering from tic douloureux. If continuous face pain is present in conjunction with attacks of tic douloureux or if operation is contemplated, such an investigation is all the more important. Many patients have had past trouble with face pain of one kind or another. Prior to the onset of tic douloureux, sinus headache, allergic headache, migraine, facial neuralgia, catarrhal headache and post-traumatic headache are common terms used by patients in describing such episodes. After experiences with the dreadful and never-to-be-forgotten tic attacks, attention is so sharply focused on the face that the character of other ill-defined pain projected into the trigeminal areas may be unintentionally colored. On the other hand, if the character of such episodes of pain is carefully analyzed, the cause will often be revealed. These relatively minor complaints by contrast are generally of little concern to the patient. However, they may be of utmost importance to the surgeon if he is to have a sound and satisfactory explanation for the patient in whom pain develops in the anesthetic or analgesic zone after operation. Too often he has told the pa-

tient that pain in the face cannot occur after root section or tractotomy. Unfortunately, this is not true. Pain of cervical origin may, and not infrequently does, appear in the face after such operations.

Even though no history of previous pain about the head, neck or shoulder is obtained, we insist on a thorough investigation of these structures including roentgen ray studies. Frequently old cervical disc lesions are found which may be activated by injury during operation when muscle defense is abolished by anesthesia and other drugs. (Fig. 4.) Should this occur and face pain develop after preoperative assurance that such is impossible, the patient's anxiety and concern is naturally aroused. Further, the surgeon has cause for even greater concern since he usually has no convincing explanation for its appearance. Therefore, if these lesions are demonstrated and a proper explanation given the patient before operation, it will save a lot of unsatisfactory conversation later.

In our cases like others tractotomy eliminated the distressing sequelae of sensory root section. On the other hand, the operation does not relieve patients suffering from so-called atypical neuralgia, nor does it eliminate continuous pain (superimposed atypical neuralgia) which occasionally accompanies tic douloureux. It is our belief that the cause of such continuous dull pain and "painful anesthesia," which at times follows root section, has nothing in common with tic douloureux or the trigeminal apparatus. Since we have recognized cervical structures as possible sources of postoperative face pain and explained to the patient the character and possible cause of such pain, we have had little difficulty in the management of this heretofore undesirable complication.

Finally, it is our present impression that tractotomy done by a simplified technic is safe in skilled hands. Further, it is effective and justifiable in the average case of tic douloureux that cannot be controlled by simple means.

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GASTRIC polyps are rare but occur more commonly in people sixty years of age and older and especially in white males. They are not half as common in colored people. The polyps may be seen by gastroscopic examination even when gastrointestinal x-rays are negative. Surgical extirpation or gastrectomy is performed depending upon the number of polypi present. If the stomach is normal otherwise and only a few polypi are present, one can make an opening into the stomach and remove these growths from the inside. If the stomach wall is involved by a great number of large and small polypi, however, one can perform as extensive a gastrectomy as is needed to remove all these tumors. (*Richard A. Leonardo, M.D.*)

SURGICAL MANAGEMENT OF ACUTE PANCREATITIS*

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IN spite of fifty years of extensive experimental research, clinical observation and advances in diagnostic aids and methods of treatment, the problems raised by acute pancreatitis are still very much with us. Granted, much has been resolved during this period, but controversy can still be raised on nearly every aspect of this interesting and important disease.

The etiology has been the subject of intensive and detailed experimentation by scores of capable workers, yet there is no universal agreement as to cause. The pathology has been well described, yet there is argument as to whether two separate forms of the disease exist, and the pathogenesis has been clarified, yet is far from clear. The diagnosis, while simplified by newer laboratory methods, is still obscure or overlooked, and the treatment, having swung from immediate surgery to conservative management in recent years, is still not answered satisfactorily in the more severe forms of hemorrhage and necrosis. It seems pertinent, therefore, to review briefly some of these aspects of the disease and to present the management as handled in the Pfeiffer Surgical Clinic of Abington Memorial Hospital during the ten-year period 1939–1949.

Concomitant with advances in knowledge of other diseases information about the pancreas has come to view and we are now considerably more enlightened than was Fitz[18] when he described a classical case of acute hemorrhagic pancreatitis in 1889. Praticularly with the widespread use of the amylase test as popularized by Elman[15,16] since 1933 are we cognizant of the frequency of the disease; we are now able to add calcium determinations to substantiate the diagnosis in many cases. In spite of voluminous writings, adequate teachings and laboratory aids, however, the diagnosis is either not clear or not considered by the family physician or the surgeon who first sees the case, with the result that surgery is often unfortunately postponed, when necessary, until the patient is seen by a clinician more familiar with the picture.

In contrast to the more conservative thoughts of many clinics in this country, we favor early surgery of pancreatitis and believe that the subject of pancreatitis should be kept before the medical profession so that such treatment can be properly instituted. We believe that our results justify this opinion and that a note of warning should be sounded to those who proclaim routine conservative management as the answer to the immediate treatment.

Forms of the Disease. Until 1933 the terms "acute hemorrhagic" or "acute necrotic" pancreatitis were used to embrace the various forms of pathology noted by surgeons and pathologists. At that time Elman[15] introduced the terms "acute edematous" or "acute interstitial" pancreatitis to name what he believes is a separate, mild form of the disease. Actually, as he pointed out, Zoeppfel[45] in 1924 had described this as a separate entity but his findings had gone relatively unnoticed. Elman gathered thirty-seven cases in which he showed that this form is a comparatively mild state which usually resolves itself in a few days although in the beginning it is indistinguishable from the more severe forms. Elman's reasoning has been accepted by many workers including Morton,[34] Abell,[1] Dragstedt and co-workers,[14] Cashberg,[7] Trasoff[43] and Popper and associates.[37]

Others such as McWhorter[32] and Ireneus[20] believe that edema of the pancreas is but the inaugural step in a process which may go on to hemorrhage, necrosis, suppuration or abscess formation. It is naturally difficult to decide this question experimentally although both states can be independently produced and Popper and associates[37] have recently shown transition from edema into necrosis by reducing the arterial blood supply to the pancreas. The basis for differentiation at present is based on diagnosis by symptoms, history and the amylase

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and calcium determinations followed by observation for several days. Should the patient improve rapidly, the diagnosis is presumed to be "acute edematous" pancreatitis. Should the patient remain ill, he is considered to fall into the "hemorrhagic" or "necrotic" group and is then a candidate for surgery. We believe that edema is but an early state of pancreatitis and that the "wait and see" policy often entail treading on thin ice. As will be discussed, it seems logical that many patients may succumb while the diagnosis is being resolved by this delay.

Etiology. The etiology is discussed in some detail since our basis for treatment is chiefly dependent on it. The prevalent opinion today as to the usual cause of pancreatitis favors the common channel theory of bile regurgitation into the duct of Wirsung due to a permanent or temporary obstructive mechanism at the ampulla of Vater. This theory is weighted by considerable evidence, clinical and experimental, and was first proposed by Opie[35,36] when he discovered in one of Halsted's autopsy cases a stone impacted at the ampulla converting into a common channel the common bile duct and the main pancreatic duct. Opie followed up this discovery by analyzing 100 autopsy specimens and concluded that in 30 per cent of these cases was a common channel theoretically possible due to impacted calculus.

Archibald,[3-4] a pioneer in this field, thought that the lodgment of a stone at the ampulla could not possibly account for all cases of pancreatitis. He advocated the theory of spasm of the sphincter of Oddi as the mechanism of common channel causation. After considerable work with cats he concluded that the sphincter of Oddi increases its resistance by increased acidity in the duodenum and also by sudden distention of the common duct through abnormal and unexpected rises of pressure in the gallbladder. This pressure, which in Archibald's experiments was 400–600 mm. water, is obtained when the gallbladder contracts forcibly due to stone or irritation. Archibald showed further that infected bile caused considerably more necrosis than normal bile and believed that this was due to precipitation of mucin, giving a higher concentration of bile salts.

The spasm theory has been revived by Doubilet and Mulholland[13] in postulating the cause of recurrent pancreatitis. They have demonstrated spasm of the sphincter by cholangiograms done on the operating table, and treated the spasm by section of the sphincter.

Mann and Giodano[29] took issue with Archibald, demonstrating that pressure in the gallbladder rarely exceeds 370 mm. water, and only by a pressure of 800 to 1,000 mm. water, obtainable by violent retching, could bile be forced into the pancreas. They dissected 200 cadavers; and although they showed that in 20 per cent a common channel was anatomically possible, in only 3.5 per cent would it function as such because an impacted stone would close the common and pancreatic ducts simultaneously. They showed further that the smooth muscle fibers of the sphincter are so arranged as to close both ducts in the event of spasm.

Cameron and Noble[6] introduced biliary calculi into the hepatic duct and stripped them down the common duct until impaction at the ampulla occurred. They then demonstrated the existence of a common channel by injection of fluid at 100 mm. water, in sixty-six of 100 unfixed specimens. Casts of the ducts made by pouring in Wood's metal substantiated the findings.

This work was confirmed by Howard and Jones[19] in dissection of 150 specimens, who arrived at a figure of 54 per cent in which a common channel existed. Rienhoff and Pickrell[38] dissected 250 cadavers and computed that a common channel was possible in 32 per cent of these cases, provided that the blocking stone was spherical so as not to block both orifices.

X-ray findings have added weight to this experimental evidence. In operative and postoperative cholangiographic studies spasm of the sphincter has been conclusively demonstrated by Mirizzi,[33] Colp and Doubilet,[9] Doubilet and Mulholland[13] and others who state that at least 20 per cent of cases show lipiodol in the pancreatic duct.

It seems reasonable to conclude that a common channel probably exists in a majority of cases. As to the mechanism causing obstruction, impacted stone can be implicated in only a small percentage. Von Schmieden and Sebening[40] in a collected review of 1,278 cases of pancreatitis record impacted stone in only 4.4 per cent; Cameron and Noble[6] record impacted stone in 22.6 per cent of thirty-one cases. Dragstedt and co-workers[14] believe that 10 per cent may show this phenomenon. Spasm un-

doubtedly accounts for a considerably larger number, and miscellaneous factors such as stricture at the ampulla (McGowan),[31] swelling (Balo and Ballon),[5] presence of ascarides (von Schmieden and Sebening)[40] or tumors probably play a minor role.

Considerably more work has been done than is mentioned here but it seems superfluous to record it all. The case for the common channel has been admirably summarized in 1943 by Jones[21] who concludes that the anatomic possibility for such a channel exists in 60 to 70 per cent of individuals and that this does occur in a considerable number of patients with biliary tract disease. This mechanism now meets with general acceptance, yet is not the complete answer.

Spread of infection via lymphatics from the gallbladder to the head of the pancreas has been advocated by Maugeret,[30] Deaver,[10] Deaver and Sweet[11] and Judd.[22] This idea was based on clinical evidence alone and was refuted by Archibald[2–4] who believed that lymphatics are invaded secondary to inflammation of the pancreas, by Kauffman[23] who could not produce pancreatitis in twenty-six cats by injecting Staphlococcus aureus into pancreatic glands, liver, gallbladder or portal vein, and by Wangensteen[42,43] who argued that if lymphatic spread were responsible, there should be more cases of pancreatitis associated with severe gallbladder infections. This theory cannot be completely denied for most observers agree that the high incidence (60 to 70 per cent) of history of gallbladder symptoms in these cases seems to indicate that biliary tree disorder is the common denominator of pancreatitis. However, it probably accounts for a minority of cases.

Other causes must conceivably act to produce pancreatitis in 30 to 40 per cent of cases. Obstruction of the pancreatic duct due to epithelial metaplasia as advocated by Rich and Duff[39] and recently by Lium and Maddock[26] may play a role. Smyth[41] believes that the vascular factor is a result of or concomitant with the disease rather than a cause of it. As Wangensteen[43] states, there are probably multiple factors at work rather than one specific agent or mechanism.

Pathology and Pathogenesis. As mentioned previously, there is dispute as to whether two forms of the disease exist. The pathology in all cases has been well described and needs no review. Jones[21] has summarized the theories as to pathogenesis and nothing of significance except the work of Popper[37] and Lium and Maddock has been added since that time.[1–4,14,35,36,39,42,43]

DIAGNOSIS AND MANAGEMENT

The clinical picture and diagnosis need little mention except to emphasize that, at least in our experience, pancreatitis is all too often neglected as a primary consideration in differential diagnosis. In our cases amylase tests were too infrequently ordered and in several instances were delayed until the time when they presented a normal reading due to recovery of the gland or complete necrosis of it.

The policy in this clinic has been that of early surgery. This does not always mean immediate surgery, but surgery as soon as the diagnosis is made or suspected and the patient can be brought into as reasonably good condition as is possible. In many cases the patient has been operated upon immediately under a mistaken diagnosis and the true condition found at the operating table, in which we prefer cholecystostomy as the procedure of choice. In many cases of early pancreatitis, perhaps the interstitial type of Elman, it is possible to perform more radical surgery, and we have done so. In the more severe forms, however, we have done cholecystostomy routinely as recommended originally by Archibald[2–4] and Deaver and Sweet.[11] Our belief is that many cases which go on to necrosis or suppuration will be aborted by this procedure whereas there undoubtedly are cases which will become inoperable during the period of observation necessary to establish the true picture. If the etiology in most cases is bile reflux due to mechanical obstruction or spasm and if in the remaining cases the etiology is obscure or undeterminable, are we not justified in doing the one thing which will do the greatest good to the greatest number, that is, relieving or removing the obstruction by biliary decompression?

The early or interstitial cases are not harmed by laparotomy, and often biliary tree disorders can be corrected in this one operation; the latter or more severe cases are given the benefit of decompression at the earliest possible time. Most writers recommend surgery for hemorrhagic or necrotic pancreatitis after the diagnosis is established by ruling out edematous or interstitial pancreatitis. We believe that the

diagnosis should be established, with kinder regard for the patient with hemorrhage or necrosis, by earlier cholecystostomy.

From other points of view early laparotomy seems justified. These cases are often handled as abdominal emergencies by capable yet comparatively inexperienced, younger surgeons who have not had the opportunity to see many such pictures, for pancreatitis is a relatively uncommon disease. If a policy of early surgery is followed, the salvage rate will be higher for many patients will come late to the hospital and the indication for surgery is present at the time of admission. Delay until an experienced surgeon recognizes the surgical abdomen conceivably means a higher mortality in a small percentage of cases. In question as to differential diagnosis between perforated, ulcer, ruptured appendix, etc., and pancreatitis, early surgery is certainly to be followed.

Cases. From 1939 to January 1, 1949, thirty-two patients with pancreatitis were admitted to Abington Memorial Hospital. Of these, thirty were cases proven by operation or autopsy. Eighteen cases can reasonably be considered to be early or edematous pancreatitis; sixteen of these patients were operated upon. The two patients who were not operated upon improved so rapidly that pancreatic involvement must have been very minimal, and surgery at no time seemed warranted. Criteria for the diagnosis of early pancreatitis as used here include enlargement or induration of the pancreas, fat necrosis or beef broth fluid, alone or in combination. It should be mentioned that enlargement of the pancreas is a variant dependent largely on the experience of the surgeon, and even the most experienced surgeon admits difficulty at times in assaying this finding.

In several instances pancreatic disorder was a more or less incidential finding; in others it was considered to be the major pathologic condition present. There was no mortality in any of the cases of early pancreatitis including the sixteen cases in which patients were operated upon. It is on this basis that we believe we are justified in recommending early surgery. These cases represent 56 per cent of all cases seen here, a somewhat lower figure than the 80 per cent given by Elman.[16] It is conceivable that many cases of early pancreatitis are so mild as to resolve without warranting hospitalization which would reasonably increase the percentage of this form of pancreatitis. There were twelve cases of hemorrhagic or necrotic pancreatitis in which operation or autopsy revealed fat necrosis, serosanguineous fluid, enlargement and induration of the pancreas and hemorrhage or necrosis of the gland parenchyma. These cases comprise 38 per cent of all cases and there were six deaths or 50 per cent mortality. One patient died before surgery could be instituted, being in severe congestive heart failure at admission, which gives an operative mortality of 46 per cent. In one instance exploratory laparotomy failed to reveal the disorder which was discovered at autopsy. In nine cases cholecystostomy was accomplished with four deaths, a mortality of 44 per cent. Analysis of these deaths shows that one patient died on the operating table from acute dilatation of the heart. One patient was an eighty-four year old female who showed congestive heart failure and gangrenous pancreatitis at autopsy. The third was a seventy-one year old female who was first seen five days after the onset of her symptoms; and the fourth showed gangrenous pancreatitis at autopsy. It is reasonable to conclude that these patients could not have been salvaged by any means. The remaining five patients made complete recovery.

Two patients with severe necrosis, gangrene and frank and miliary abscesses of the pancreas were seen, both of whom died following cholecystostomy.

A few interesting points are brought out in this series. The male:female ratio (13:19, respectively) is lower than that given in most series except for that of MacGuire and Conte.[28] All patients were white. Our percentage of history of previous biliary tree symptoms or pathology (58 per cent) is somewhat lower than the 65 to 70 per cent usually quoted.[14,17,34] That the diagnosis is difficult is seen from the recorded preoperative diagnoses in which the diagnosis was made in only ten cases although it is admitted that until recently the amylase test was not used as frequently as it might have been.

Early surgery provided better results than delayed surgery, which would indicate that the progress of the disease had been halted by decompression. Seven patients operated upon less than forty-eight hours after an attack showed 28.5 per cent mortality, one patient operated upon between forty-eight to ninety-

six hours died, and three patients operated upon more than ninety-six hours after attack showed 66.6 per cent mortality.

ANALYSIS OF RESULTS

In the group of early or edematous pancreatitis we have had no mortality in sixteen cases in which patients were operated upon. Conservature therapy might have resulted in a similar figure since all writers agree that the mortality in this form is less than 10 per cent. Whether some of these cases, would have progressed to necrosis or hemorrhage without surgery cannot be surmised. MacGuire and Conte[28] recently have found that abscesses not infrequently develop after conservative treatment and believe that perhaps cholecystostomy and drainage of the lesser sac is indicated in some cases. Many cases came to surgrey late because pancreatitis was not recognized and the surgeon delayed in order to allow an acutely inflamed gallbladder to subside or a diagnosis of chronic cholecystitis to be confirmed by *x*-ray, etc. That the pancreatitis had not progressed during this interval confirms Elman's[15] reasoning that perhaps these cases are distinct entities. In any event we have performed surgery on these patients without fatality; and if the diagnosis of acute pancreatitis had been made earlier, we would have operated earlier.

The group with necrosis shows six deaths in twelve cases, with an operative mortality of 46 per cent. One was possibly a surgeon's error in that the diagnosis was not made at laparotomy. Possibly the necrosis developed between the operation and death twenty-four hours later. Another patient was not operated upon due to severe myocardial failure which could not be cleared in order to perform surgery. One patient died on the table from acute dilatation of the heart, one was a severe case in an aged person, one came late to the hospital, and one showed gangrene of the pancreas at autopsy. These deaths cannot be erased from a computation of mortality but they detract from the over-all impression of high mortality.

Published mortality figures vary considerably and older ones, before 1933, are probably inaccurate. Linder and Morse[27] report 26 per cent mortality, Cole[8] 50 per cent, Lampson[24] 14 per cent in twenty-nine cases of which thirteen were severe, McWhorter[32] 49 per cent, Abell[1] 30 per cent, deTakats and MacKensie[12] 36.6 per cent and MacGuire and Conte[28] 26 per cent. Our figures fall within this range, hence we believe that we are doing the right thing when we operate early. MacGuire and Conte[28] reported better results when patients were operated upon rather than when not operated upon, but felt unable to break down their cases into pathologic groupings. Lewison[25] has stated, "Regardless of the operation, the operator or the lack of operation, the mortality of this condition appears to be primarily a result of the pathologic process in the pancreas, and future therapy will undoubtedly be governed by the progress made toward better understanding and control of the origin of pancreatic necrosis." This is still a wise observation; but until the understanding of the origin of necrosis is clarified, we believe that early cholecystostomy is the procedure of choice.

We do not attempt to drain the pancreas for this is impossible to do adequately. Occasionally we leave a small cigarette drain at the foramen of Winslow; in the cases of suppuration we have drained more adequately. Drainage accomplishes little in the early or moderate cases and is not indicated unless suppuration occurs.

Complications. Complications following surgery have been surprisingly few considering the nature of the disease. In one patient empyema and a subdiaphragmatic abscess developed which necessitated drainage. One patient disrupted his wound which required secondary suture, and there was drainage from his cholecystostomy for several weeks. He was readmitted several months later with an attack of cholecystitis or pancreatitis which subsided spontaneously in a few days. A third patient returned three years following cholecystostomy with mild epigastric distress which subsided in a few days' time. Although a systematic follow-up has not been carried out, the others have remained well to the best of our knowledge. None has returned for additional surgery.

SUMMARY

1. Considerable work has been done in the various phases of acute pancreatitis but the complete picture is not yet clearly resolved.

2. A brief review of the forms, etiology, pathogenesis and treatment is given.

3. Thirty-two cases of acute pancreatitis

occurring within a ten-year period are presented, with an over-all mortality of 25 per cent.

4. Sixteen patients with early or edematous pancreatitis were operated upon without fatality.

5. Eleven patients with severe pancreatitis were operated upon with an over-all mortality of 46 per cent.

6. Cholecystostomy was performed as the procedure of choice in the severe forms of pancreatitis.

7. Correction of biliary tree disorders can usually be carried out in the mild forms of pancreatitis no matter when the operation is performed.

8. Early operation is recommended as the treatment of acute pancreatitis.

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SWEATING PATTERNS FOLLOWING DORSAL AND LUMBAR SYMPATHECTOMY*

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REGIONAL sympathectomy is rapidly becoming a popular supplement to the conservative treatment of vascular disease of the extremities. Its use in the treatment of certain allied conditions including causalgia,[13] hyperhidrosis,[6] and allergic and dermatologic disorders[1] is being promoted with enthusiasm.

Inasmuch as there is more than one way of doing a sympathectomy there will probably never be complete agreement among surgeons as to which procedure is best. One reads of the disadvantages of "adrenalin sensitization" phenomena associated with postganglionic sympathectomy and must weigh them against the "regeneration hazards" of preganglionic sympathectomy. The majority of authors, however, including Reginald Smithwick, the dean of sympathetic surgeons in this country, have been won over to the latter procedure and use the preganglionic type of denervation wherever possible.[19]

Whichever type of procedure is used, the conscientious surgeon will be anxious to know postoperatively to what extent sympathectomy has been accomplished and at what level. Fortunately, the absence of sweating may be used as a criterion of sympathetic denervation, and through the use of this modality the effects of surgery upon the sympathetic nervous system have been largely studied. Certain experiments concerning the physiology of sweating are of particular interest. It has been demonstrated that following the application of heat to the skin the sensory side of the reflex arc is unnecessary but that the motor side (sympathetic fibers) are essential for the normal sweating response. These findings suggest that heated blood acting on the central nervous system is the cause of generalized sweating.[4] By experiments in which sympathetic nerves have been crushed it has also been demonstrated that sweat glands do not atrophy but retain their ability to respond as soon as innervation has been restored.[11]

The degree of sweat gland activity bears a direct relation to the resistance offered by the skin to the passage of a direct current between two electrodes.[18] A denervated area of skin will average about 100 times the electrical resistance of normal skin as measured in ohms on a dermometer (ammeter).[17] Although this method allows very rapid and accurate skin mapping,[16] it is less widely used than the starch-iodine method of Minor. This latter method is less accurate and more cumbersome but lends itself nicely to photography. The patient is first painted with an iodine-castor oil mixture, then powdered with dry starch and finally made to sweat with the aid of heat, salicylates and hot tea, the latter two administered before the application of heat. The iodine-starch mixture turns black wherever moisture (sweat) is added. An alternate method of causing the patient to sweat consists of the hypodermic injection of pilocarpine in doses of $\frac{1}{5}$ gr. Ultimately the zone of pilocarpine anhidrosis agrees precisely with the zone of thermoregulatory anhidrosis in the sympathectomized patient, provided a postganglionic sympathectomy has been performed.[8,9]

It is doubtful if any of the present methods of sympathectomy result in a complete interruption of all sympathetic pathways. All observers who have followed patients for a period of three months after sympathectomy report significant changes in the sweating patterns. As the cutaneous areas of anhidrosis shrink, the return of sympathetic activity must be conceded. Ray and Console in a study of 291 sympathectomies on 151 patients found the lower extremity not completely denervated even after total sympathectomy from the stellate ganglion

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through L5. This sympathetic activity was abolished only after sectioning of the anterior spinal roots from T12 through L3. It then became apparent that sympathetic activity in the T12 to L3 dermatomes is present in all patients after standard sympathectomy. These workers also concluded that these fibers do not pass through any part of the paravertebral sympathetic chain, but rather through the anterior spinal roots out to well hidden ganglia elsewhere. These residual pathways could be blocked by anterior rhizotomy, spinal anesthesia, tetraethylammonium chloride, procaine block or division of the lumbar nerves. Similar pathways are probably distributed widely throughout the body as is demonstrated by the return of sweating in patchy areas wherever sympathectomy has been performed. Return of sympathetic activity during the first three months is probably due to the previously described mechanism; that occurring later may be explained by regeneration of the postganglionic nerves.[9,12,14]

The inherent ability of the smooth muscle of the blood vessels to maintain an independent tone probably limits the early and late effectiveness of sympathectomy more than any other factor.[3] It is now generally agreed that the treatment of peripheral vascular disease by sympathectomy is more satisfactory in the lower than in the upper extremity. The lumbar sympathectomy has always been predominately a preganglionic denervation; but until Smithwick described his new technic in detail in 1940, the dorsal sympathectomy had been essentially a postganglionic neurectomy. It was believed that when a large series of upper extremities had received preganglionic sympathectomies, results comparable to those obtained with lumbar sympathectomy could be expected. Although moderate improvement in results has been reported, expectations have not been met. Possibly this may be explained by the fact that the lower extremities due to their dependent position are more actively influenced by sympathetic vasomotor tone of proprioceptive origin.[3]

The preganglionic fibers for the upper extremity originate in the intermediolateral cell column from the fourth through eighth dorsal segments of the spinal cord. They pass out of their respective ventral roots, through white rami communicantes and then ascend the sympathetic trunk to synapse in the second thoracic ganglia and/or below.[8] Postganglionic fibers from T1 and the stellate ganglion innervate the sweat glands of the shoulder, neck and face. Postganglionic fibers from T2 and T3 innervate their respective segments.[10]

The most widely accepted operative technic for denervation of the upper extremity is the previously mentioned procedure of Smithwick which is described elsewhere in this paper. Denervated areas following this and other cervical and upper thoracic procedures have been studied extensively by Richter. In forty-five cases of upper thoracic operations there was complete sympathetic denervation of the upper extremity in all except one case, and in this case it was believed that all of the upper thoracic chain had not been removed. The upper thoracic procedures used in these forty-five cases consisted of removing T1 through T4 in five cases, removal of T2 and T3 in six cases, Smithwick preganglionectomy in twenty-nine cases, removal of T1, T2 and T3 in three cases and removal of T2 in two cases. Also, six cases of stellate ganglionectomy were studied and incomplete denervation of the upper extremity occurred in five of them. A removal of only the second dorsal ganglion constitutes as complete a sympathectomy as removal of the inferior cervical and upper two dorsal ganglia insofar as central connections are concerned for the upper extremity as reported by Hyndman et al.[9] From these studies we are obliged to conclude that sympathetic denervation of the upper extremity depends upon the removal of T2 inasmuch as this ganglion was the common denominator in all the upper thoracic ganglionectomies and resulted in complete denervation of the upper extremity in the cases in which it was resected alone. As noted in one case in our series in which the third and fourth intercostal nerves and associated sympathetic rami for these levels were divided instead of the second and third, the sweating pattern showed no change from the normal. Upon reoperation the second intercostal nerve, associated rami and sympathetic chain were divided; following this the patient showed marked clinical improvement with complete loss of sweating of the upper extremity.

Resection of the upper four thoracic ganglia resulted in the denervation of the entire arm, half the head, neck and chest down to a level just below the nipple. When only T2 and T3 are removed, the area of denervation on the chest extends down to just above the nipple

but otherwise is the same as the more extensive ganglionectomy. The Smithwick procedure gives the same sweating pattern as ganglionectomy of T2 and T3 as far as the upper extremity and upper chest are concerned. With removal of T2 alone the entire upper extremity and a small segment of chest are denervated, but the head and neck escape entirely. Stellate ganglionectomy results in denervation of half the head, neck, shoulder and the outer aspect of the upper arm. With the Smithwick sympathectomy partial anesthesia is present in skin areas of high electrical resistance (denervated areas).[15]

The cell bodies of preganglionic sympathetic neurones which innervate the lower extremity arise in the intermediolateral cell column from the tenth dorsal to the third lumbar segments. They pass caudad via their white rami communicantes and synapse in ganglia in the lumbar and sacral part of the chain. Postganglionic fibers join the lumbosacral plexus segmentally as gray rami, i.e., L4 to S3 for the sympathetic fibers joining the sciatic nerve and L1 to L3 for fibers joining the femoral and the obturator nerves.[2]

The usual lumbar sympathectomy consists of removing a segment of lumbar chain which includes the second, third and fourth ganglia. This is essentially a preganglionic sympathectomy in the removal of the second and third ganglia and a postganglionic sympathectomy in the removal of the fourth ganglion.[2] The operator must keep in mind that bilateral removal of the first lumbar ganglion in men results in loss of ejaculation in 21 per cent of cases and hence sterility.[12]

Postoperative sweating patterns observed within the first few days after operation give the surgeon a fairly accurate picture of the extent of sympathectomy. This picture changes constantly during the ninety days following surgery, but in the average case in which L2, 3 and 4 have been removed there will be absence of sweating over the entire lower extremity with the exception of the thigh anteriorly. By studying the pattern on the anterior aspect of the lower extremity the surgeon can usually tell if he missed one or more of the essential ganglia. This study will be made easier if the surgeon will recall that the area of sympathetic denervation will correspond roughly to the sensory radicular pattern of cutaneous innervation. This pattern may be simplified in chart form.[14]

Denervation of Anterior Aspect of	Segmental Level of Lesion
Foot	S1
Ankle	L5
Lateral leg	L4
Medial leg	L3
Medial thigh	L2
Lateral thigh	L1

A series of sweating patterns on the average patient will show a stabilized pattern after sixty to ninety days in which diminished but definite sweating is present down to the level of the knee anteriorly and somewhere in the middle or lower third of the thigh posteriorly, although in our series in which L2, 3 and 4 were removed there was consistent absence of sweating on the posterior aspect of thigh and most of the buttock (Figs. 3, 4, 9 and 10), except for sweating along the most medial and lateral borders of the posterior surface of the thigh. It is of interest to note that the final stable pattern following lumbar sympathectomy is not affected by removal or preservation of the first lumbar ganglion.[14]

TECHNIC

Dorsal Sympathectomy. The operative procedure performed for sympathetic denervation of the upper extremity was the method described by Smithwick. The skin incision was placed about 2 to 3 inches from the midline centered between the third and fourth dorsal spinous processes. This incision was carried through the skin and superficial fascia. The trapezius muscle was split vertically and the rhomboideus major muscle was split transversely. The splenius cervicis and capitis muscles were freed from the third rib posteriorly at the region of the angle and third transverse process. About 2 to 3 inches of the third rib were resected subperiosteally from the angle to its attachment to the transverse process. The transverse process of the third dorsal vertebra was likewise partially resected. The parietal pleura was then stripped from the chest wall. The second and third intercostal nerves were visualized and dissected free from the surrounding structures. The intercostal nerves were transected lateral to the formation of the common nerve trunk. By traction on the medial cut end of the nerves the dissection was carried medialward bringing into view the dorsal sensory branch, posterior and ventral roots and the white and grey rami. All of these structures

were divided. The dorsal sympathetic chain was then dissected free from the anterolateral aspect of the thoracic vertebra and the chain was then divided below the level of the third dorsal sympathetic ganglion. The wound was then closed in layers using either catgut or silk.

Lumbar Sympathectomy. The skin incision was made at the level of the umbilicus, either left or right side depending upon the extremity to be denervated. The incision was transverse midway between the costal arch and the crest of the ilium. The muscles of the abdominal wall were split in the direction of their fibers. The retroperitoneal space was entered displacing the peritoneum anteriorly and medially and stripping the fat from the posterior body wall. By means of lap pads and retraction the posterior body wall to the region of the vertebral column was visualized. The lumbar sympathetic chain was then freed from the surrounding structures; on the right the inferior vena cava was retracted medially and on the left the aorta was likewise retracted.

The sympathetic chain was then dissected upward, dividing all of its communications and branches. The dissection was carried at least above the second lumbar ganglion; in some cases the first ganglion was removed. The dissection was then carried downward to the promontory of the sacrum where the chain and all its communications were divided removing the lumbar chain and ganglia from the second through the fourth lumbar levels.

The abdominal wound was then closed in layers using silk sutures. Patients were ambulatory on the first postoperative day. Recently bilateral lumbar sympathectomies where indicated were performed at one time through a bilateral approach as previously described. The postoperative course in all cases has been uneventful and patients were ambulatory on the first postoperative day.

Case Reports. During the period from October 15, 1946, to January 28, 1949, fifty-nine patients were operated upon and eighty-three operations were performed. Fifty-five patients had lumbar sympathectomies; twenty of these patients required a bilateral procedure. Five patients had dorsal sympathectomies, two in the group required bilateral operation and one patient required reoperation.

Tables I and II list the diseases and number of patients treated.

The surgical procedures were accomplished in about equal frequency in both the right and left sides in both the upper and lower extremities.

There were fifty-nine postoperative sweating tests performed on forty-two of the fifty-nine sympathectomized patients. Of the forty-two patients who had sweating tests performed, thirty patients had one postoperative test, seven had two tests and five had three tests.

Table III lists the number of sweating tests performed at various intervals postoperatively. In some cases sweating tests were performed and repeated at intervals because of the fact

TABLE I
LUMBAR SYMPATHECTOMIES

Diseases	No. of Cases	
	Unilateral	Bilateral
Arteriovenous aneurysm, left hypogastric artery	1	0
Arteriosclerosis	3	0
Arteriosclerosis, diabetic	2	2
Buerger's disease (thrombo-angiitis obliterans)	6	10
Causalgia	4	0
Frost bite and trench feet (residuals)	1	3
Indolent ulcer, leg	2	0
*Peripheral vascular disease	14	2
Scleroderma	0	1
Thrombophlebitis, chronic	2	2
Total	35	20

* Cases were placed in this classification when a definite diagnosis could not be established.

TABLE II
DORSAL SYMPATHECTOMIES

Diseases	No. of Cases	
	Unilateral	Bilateral
Buerger's disease (Thrombo-angiitis obliterans)	0	2
Causalgia, right upper extremity	1	0
Causalgia, left hand and wrist	1	0
Coronary-sclerosis—anginal syndrome	0	1
Total	2	3

that the patient was operated upon at different times for involvement of other extremities as illustrated in the case of the patient whose photographs are included in this article.

TABLE III
TIME INTERVAL OF POSTOPERATIVE SWEATING TESTS AND NUMBER OF CASES

Days Postoperative	Lumbar Sympathectomies		Dorsal Sympathectomies	
	Right	Left	Right	Left
7–10	10	13	1	0
11–20	10	12	1	1
21–30	5	4	1	1
31–40	1	3	1	0
41–50	0	0	0	1
51–75	1	1	0	0
76–100	1	0	0	0
101–200	2	2	1	0
201–300	2	2	0	0
301–400	3	2	0	0
401–500	0	1	1	0
501–600	1	1	0	0
601–700	2	2	0	0

TYPICAL STABILIZED POSTOPERATIVE SWEATING PATTERNS

Figures 1 to 10 are representative of our findings in dorsal and lumbar sympathectomies. The following sympathectomies for Buerger's disease (thrombo-angiitis obliterans) were accomplished on this patient:

Right Lumbar	March 6, 1947
Left Lumbar	March 15, 1947
Left Dorsal	December 22, 1947
Right Dorsal	January 9, 1948

The first sweating test (Figs. 1 to 4) was performed on January 20, 1948, which was 300, 291, twenty-nine and eleven days following the aforementioned respective surgical procedures. The head and neck were not included in any of the sweating tests.

Figure 1. There was absence of sweating of left upper chest (dermatomes C4, T2, T3) and the entire left upper extremity on the twenty-ninth postoperative day. The dark area below the antecubital fossa is a tatoo mark. On the right, however, there was sweating throughout on the ninth postoperative day.

Figure 2. There was complete absence of sweating below the knees. This is a stabilized pattern since it is 300 and 291 days following the right and left lumbar sympathectomies, respectively. Sweating on the thighs covered dermatomes L2 and part of L3.

Figure 3. There was absence of sweating of left upper back (dermatomes C4, T2 and part of T3) and entire left upper extremity. On the right there was normal sweating over dermatomes C4, C5 and 6 (small, somewhat round, dark area near midline below base of neck) but there was absence of sweating over dermatomes T2 and more of T3 than on the left. The right upper extremity also showed normal sweating except over the elbow where sweating was absent to pin-point, but it is not at all unusual for sweating to be diminished or absent over a bony prominence.

Figure 4. The crescent-shaped curve across the lumbosacral region and down the lateral portion of each buttock and thigh is a remarkably consistent pattern in an L2, 3, 4 preganglionic lumbar sympathectomy bilaterally, and the same pattern outline exists *unilaterally* if the same side is sympathectomized. Usually sweating stops at the junction of the middle and lower thirds of the thigh laterally. Sweating is also present along the medial border of the thighs and upper third of each leg. Usually, however, this sweating stops at the knee. Sweating is absent below dermatomes L2 and part of L3.

At this point it was realized that the right preganglionic dorsal sympathectomy removed portions of the third and fourth intercostal nerves, anterior and posterior roots and the white and gray rami instead of the second and third. Accordingly, the right dorsal preganglionic sympathectomy was repeated on January 27, 1948, this time removing a portion of the second intercostal nerve, roots and rami, and sectioning of the dorsal sympathetic chain below the second dorsal ganglion.

The second sweating test, Figures 5 and 6, was performed on February 4, 1948.

Figure 5. There was a return of light confluent sweating on left upper chest. Forty-four days postoperatively, with continued absence on the left upper extremity. There was light confluent sweating of the right upper chest and upper two-thirds of the right arm, and absence of sweating below.

Figure 6. There was a return of sweating of the left upper back and continued absence on the left upper extremity as well as absence of

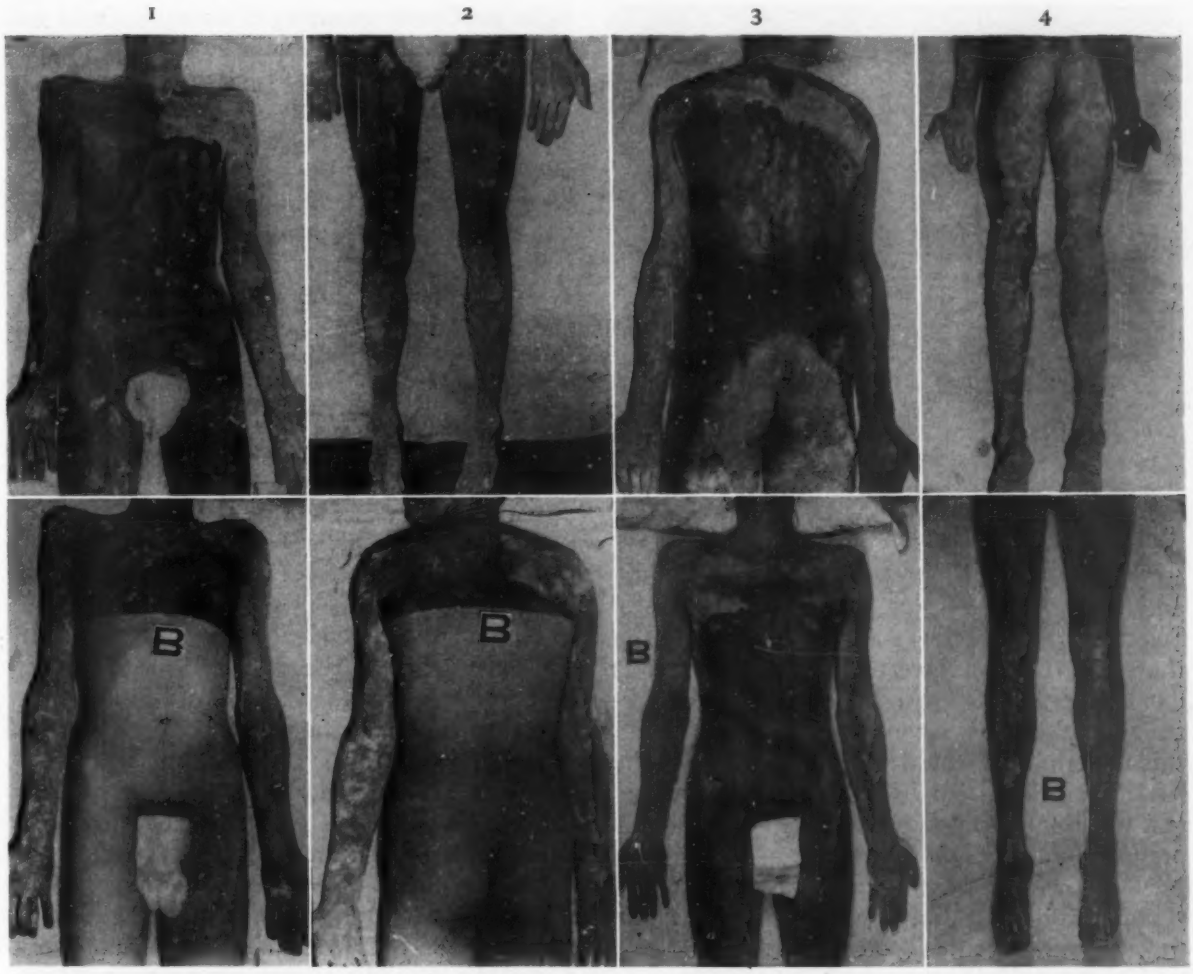
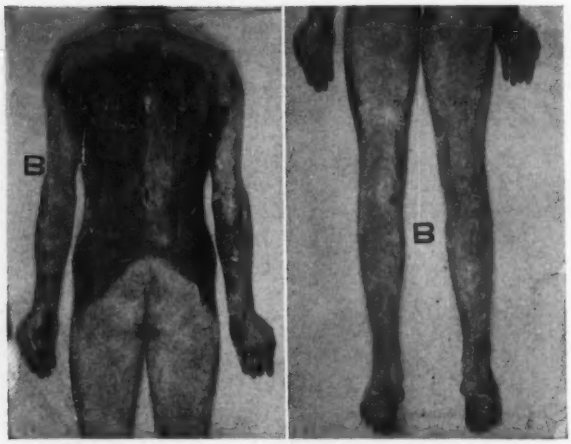


FIG. 1. Absence of sweating, left upper extremity and chest; present on right; anterior view.
FIG. 2. Absence of sweating, both lower extremities, below knees; anterior view.
FIG. 3. Absence of sweating, left upper extremity and back; partial absence, right back; posterior view.
FIG. 4. Absence of sweating, both lower extremities and buttocks; posterior view.
FIG. 5. Absence of sweating, both upper extremities, except upper part right arm; anterior view.
FIG. 6. Absence of sweating both upper extremities, right upper back; posterior view.
FIG. 7. Absence of sweating, upper chest and extremities, except small area on forearms; anterior view.
FIG. 8. Continued absence of sweating below knees; anterior view.

sweating of the right upper back and upper extremity.

It was somewhat disappointing not to find complete absence of sweating of the right upper chest and arm anteriorly and return of sweating of the left upper chest and back. This latter cannot be explained on the basis of regeneration for two reasons. First, it is too early; secondly, the type of sympathectomy performed is inclined to preclude regeneration. It might, however, be explained by a process of readjustment[14] or by innervation through the first thoracic root or supraclavicular nerves[9] although there is no evidence that the first thoracic white ramus carries either vasomotor or sudomotor fibers of consequence to the upper extremity in man.[19] However, the third sweating test (Figs. 7 to 10) showed that sweating again disappeared which would seem to make the hypothesis of readjustment and innervation untenable. Furthermore to be considered is that the high level of surface temperature and skin resistance which is maintained for the first few days after operation undergoes a curious depression, which occurs as a rule from the third to the fifth or sixth day and disappears after thirty-six to forty-eight hours.[19] It is thought that this suggests that spontaneous activity arises in the decentralized sympathetic ganglia. This might explain the presence of sweating on the right upper chest



9 10

FIG. 9. Absence of sweating, upper back and extremities, buttocks posterior view.
FIG. 10. Continued absence of sweating, lower extremities, posterior view.

and most of the arm anteriorly. (Fig. 5.) Sweating, however, was absent posteriorly, on the right (Fig. 6) since this sweating test was done eight days following the second right preganglionic dorsal sympathectomy. However, this explanation would not be tenable on the left upper chest and back since this sweating test was done forty-four days following the left preganglionic dorsal sympathectomy.

A follow-up sweating test (Figs. 7 to 10) was performed on January 10, 1949. This was 676 and 667 days following the right and left preganglionic lumbar sympathectomies, respectively, 349 days following the second right dorsal preganglionic sympathectomy and 385 days following that on the left.

Figure 7. Sweating was completely absent on the upper chest bilaterally (dermatomes C4, T2, T3 and part of T4 on the right) and both upper extremities except for a narrow longitudinal area of light sweating along the midportions of both forearms. This photograph as well as Figure 9 is the cause of the somewhat prolonged hypothetical considerations discussed herein.

Figure 8. There was absence of sweating distal to the knees except for a small amount of pin-point sweating in the anteromedial aspect of the right leg and medial border of the left leg which was not present in Figure 2.

Figure 9. There was absence of sweating on the upper back bilaterally (dermatomes C4, T2 and part of T3, and a small portion of T4 laterally on the right). The upper extremities showed absence of sweating except for a small island of light confluent sweating over each axilla and pin-point to light confluent sweating along the posteromedial border of each arm, forearm and dorsum of the hands.

Figure 10. For most of the buttocks see Figure 9. Compare Figure 10 and lower portion of 9 with Figure 4. The pattern of absence of sweating remains unchanged. In fact, in this last sweating test the intensity and extent of sweating on the lateral and medial borders of the thighs and the upper medial borders of the legs are less than on Figure 4.

COMMENT

The postoperative sweating tests in the forty-two cases studied revealed a definite and consistent pattern in both the upper and lower extremities. In all these cases the operative procedure and extent of the resection were identical.

The sympathetic denervation of the upper extremity can be accomplished, without evidence of regeneration, by the division and removal of the rami, ventral and dorsal roots of the second and third intercostal nerves. It appears, as presented in one case, that the cell stations are in, and the main postganglionic neurones leave the second dorsal ganglion and that these neurones pass into the second intercostal nerve. A division of these structures at this level will result in a complete sympathetic denervation of the upper extremity and portions of the chest and back without a Horner's syndrome. It appears from the experience and findings in this case that the division of the dorsal and ventral roots of the third and fourth intercostal nerves and white and grey rami will not result in sympathetic denervation of the upper extremity. The findings confirm the report of Hyndman et al.[9] that the cell stations to the upper extremity are located in the second dorsal ganglion. The removal of this ganglion alone would not insure against regeneration and resumption of sympathetic function; therefore, to insure permanent results the surgical resection should include the adjoining rami and roots of the second intercostal nerve.

In all previous cases in which patients had dorsal sympathectomies the procedure consisted of the operation as described elsewhere in this paper. However, it appears that a complete and permanent sympathetic denervation of the upper extremity can be accomplished by the division of the white and gray rami and resec-

tion of a portion of the common nerve trunk of the second intercostal nerve and its ventral and dorsal roots. Further studies seem indicated in this type of procedure to establish these facts definitely. Both Goetz[2] and Hyndman[9] have shown that sympathetic denervation can be accomplished by cauterization or removal of the second dorsal ganglion.

The sweating patterns of the lower extremities following lumbar sympathectomy in which the second, third and fourth ganglia and chain were removed are consistent and showed no shrinkage or return of activity even after two years. The operation was primarily and predominantly preganglionic in type but also transected postganglionic neurones in all levels, but particularly in the fourth lumbar segment. This procedure apparently has not caused any unfavorable results in either the sweating patterns or clinical results.

It is worthy of note at this time that the main cell stations for the preganglionic supply to the upper and lower extremities are located in the second ganglion in the dorsal and lumbar regions, respectively.[2,9] This seems to be a logical plan and one may compare the pre- and postganglionic neurones to the upper and lower motor neurones of the somatic nervous system.

SUMMARY AND CONCLUSIONS

1. The subject of sympathetic denervation of the extremities has been discussed, with particular emphasis on the importance of obtaining postoperative sweating patterns and the significance of such patterns.

2. The postoperative sweating patterns become stabilized after a period of time and remain constant, even after a period of years, if the surgical procedure has been anatomically complete and predominately preganglionic in type.

3. The main cell stations for the preganglionic neurones appear to be located in the second dorsal and second lumbar ganglia, respectively, for the upper and lower extremities.

4. Our knowledge of the sympathetic nervous system is far from complete and recent reports from various groups have brought to light new findings and a more accurate localization of important centers.

5. Continued studies such as sweating patterns, electrical skin resistance tests and use of various cholinergic drugs in sympathectomized patients will bring to light a more thorough knowledge of the physiology and anatomy of this important nervous system.

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ANATOMIC RELATIONS OF THE VAGUS NERVES TO THE ESOPHAGUS

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INTEREST in vagotomy for the treatment of gastric and duodenal ulcer, as described by Dragstedt,[1] prompted this anatomic study of the vagus nerves.

Textbooks of anatomy describe the arrangement of the vagus nerves on the esophagus in brief and general terms. Numerous writers have described and illustrated the abdominal distribution of the vagus nerves but until recently only a few have made more than passing note of the relation of these nerves to the esophagus. Swan,[2] Bourgery,[3] Kollman,[4] Wertheimer,[5] McCrea,[6] Brauecker[7] and Teitelbaum[8] have published reports about the distribution of the vagus nerves. In general these authors described the nerves as emerging from behind the right and left lung roots and dividing into several branches. Such branches arrange themselves along the anterior and posterior surfaces of the esophagus in such a manner as to form a plexus around its lower third. From the plexus a varying number of trunks descend through the esophageal opening of the diaphragm and are distributed to the surfaces of the stomach as well as to the celiac and related nerve plexuses.

Dragstedt[1] illustrated two main vagal trunks above the diaphragm and stated that the main trunks of the left or anterior vagus and the right or posterior vagus are easily secured. In addition most cases present a varying number of branches which can be grouped into two main bundles and ligated. Recently Bradley et al.[9] and Miller and Davis[10] reported anatomic studies of the vagus nerves. The former described a rather uniform arrangement, particularly around the lower end of the esophagus, in approximately 90 per cent of the cases studied. Miller and Davis, however, emphasized the marked variation seen in the study of a smaller series of cases.

MATERIAL STUDIED AND RESULTS

This investigation was made on fifteen cadavers, fourteen males and one female. All were more than forty years of age. The thoracic portions of the vagus nerves were carefully dissected and their arrangement from the lung root to the diaphragm studied.

In eleven of the fifteen cadavers the relationship of the vagus nerves to the esophagus assumed a fairly constant pattern. (Fig. 1.) One large trunk issued from the posterior surface of each lung root, usually accompanied by three or four small filaments from the corresponding pulmonary plexus. These filaments either joined the large trunk of the same side or entered into the formation of a plexus on the surface of the esophagus. In all cases there were varying numbers of communicating branches around the esophagus between the right and left nerves. This resulted in a plexus formation of nerves about the middle one-half of the portion below the lung root.

The left vagus in every cadaver divided into two branches which retained their identity throughout the esophageal plexus and a variable number of smaller branches which communicated freely over the esophageal wall. One of the larger branches assumed an anterior position along the esophagus and formed the greater portion of the anterior gastric nerve. The other large branch passed around the left border of the esophagus, contributed to the plexus on its posterior surface and finally joined branches from the right vagus at a variable level above the diaphragm to form the posterior gastric nerve.

Soon after emerging from behind the lung root the right vagus divided into a number of branches, many of which were lost in the esophageal plexus. One larger branch could be

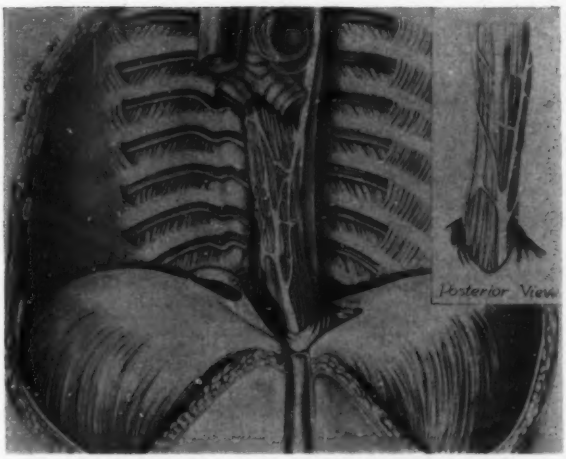

FIG. 1. Usual distribution of branches along esophagus forming anterior and posterior gastric nerves as seen in eleven cadavers.

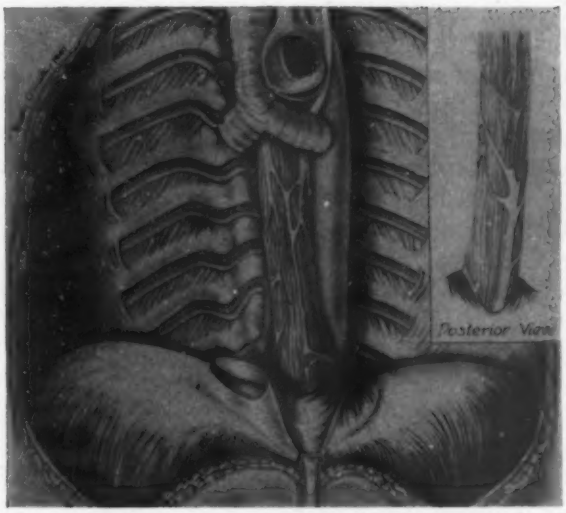

FIG. 2. Shows branches of anterior vagus nerve encircling left side of esophagus and joining post-gastric nerve.

traced around the right surface of the esophagus a short distance below the lung root and formed the major portion of the posterior gastric nerve. The smaller branches entered the plexus on the anterior surface of the esophagus; some helped form the anterior gastric nerve whereas others reunited to form a trunk which passed around the right border of the esophagus 2 to 4 cm. above the diaphragm and joined the posterior gastric nerve. (Fig. 1.)

Many small branches of both nerves entered the muscular wall of the esophagus. None of these could be demonstrated to emerge from the esophagus and rejoin the other nerve fibers.

The level at which the anterior and posterior gastric nerves could be identified as individual trunks varied from 4 to 1 cm. above the diaphragm. They either issued from the esophageal plexus rather abruptly or were formed by a gradual convergence of fibers over a distance of 2 to 3 cm.

There were four cases in which the general pattern described heretofore was not seen. In three of these more than two trunks issued from the lower end of the plexus and passed through the esophageal opening of the diaphragm. In one (Fig. 2) the anterior gastric nerve split into four small branches. Two of these branches united to form a single loop that arched around the left border of the esophagus and passed through the diaphragm on its posterior aspect while the remaining two branches proceeded downward on the anterior surface of the esophagus. In another case two well defined trunks issued from the posterior part of the plexus and passed through the diaphragm behind the esophagus while the anterior gastric nerve was present as a single trunk. In a third instance two well defined trunks passed through the diaphragm anteriorly and one posteriorly. Finally there was one case in which a small but well defined nerve came of the left vagus just below the lung root, passed laterally into the fibrous tissue on the anterior surface of the aorta and accompanied the aorta to just above the diaphragm where it joined the posterior gastric nerve. These last three cases have not been illustrated.

COMMENT

The arrangement of the vagus nerves immediately below the pulmonary plexuses have little significance in regard to the anatomy encountered in vagotomy. However, we have found them fairly constant at this level.

From just below the lung roots to within 4 cm. of the diaphragm the predominant feature of the nerve fibers is the plexiform arrangement. Individual vagal elements are difficult to define, even with the esophagus widely exposed. It would be even more difficult to secure all the nerve fibers at this level with the usual surgical exposure.

Around the lowest part of the thoracic esophagus the nerves showed the most constant arrangement. In approximately three-fourths of the cases described all vagal elements could be secured in two trunks. The relative positions of these trunks at the esophageal opening of the diaphragm has been described by Bradley et al.[9]

Even in those cases in which the variations were found the lower end of the esophagus remained the site of choice for securing all vagal fibers. In these instances the fibers were not as scattered as they are at higher levels and can usually be secured in three or four trunks. Bradley et al.[9] described instances in which branches left the main trunks and lost their identity in the thorax. In our only case of this sort the filaments left the vagus trunk at a high level and could be traced back into the posterior gastric nerve. Thus far we have not encountered all the variations described by Miller and Davis.[10]

It appears obvious that regardless of the surgical approach used, securing all nerve fibers will be much less difficult if the lowest portion of the esophagus is exposed.

SUMMARY

The arrangement of the nerve fibers along the esophagus from the lung root to the diaphragm, as seen in fifteen cadavers, is described. The arrangement most commonly seen and one of the variations are illustrated and brief mention is made of the surgical significance of these findings.

Acknowledgment: For preparation of the illustrations the authors wish to express their appreciation to Mr. Lewis Waters, Professor of Medical Art and Visual Education, and to Miss Patty O'Neil of the Department of Medical Art.

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SURGICAL ANATOMY OF THE THYROID GLAND

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IN 1916 deQuervain[16] wrote, "Goiter operations are based on one of two principles: either the surgeon follows no special plan, excising the goiter as he would any other tumor and ligating the blood vessels as they bleed, or he follows methodically a definite plan based on the anatomy of the thyroid." The operation for thyroidectomy requires an exact knowledge of many important structures. The following discussion takes up the important structures that are encountered or may be encountered during thyroidectomy in the order of their occurrence during the operation.

STRUCTURES SUPERFICIAL TO THE DEEP FASCIA

The structures superficial to the investing layer of the deep cervical fascia are the skin, the superficial fascia, the superficial nerves and the superficial veins.

The skin of the neck presents lines and creases which should be followed when incisions are made to minimize scars and contractures. (Fig. 1.) The most common skin incision for thyroidectomy is the low collar or Kocher incision, slightly convex downward with the lowest part of the convexity being about 1 inch above the suprasternal notch. The incision so placed should be covered by a string of beads.[8,13,27,30,31,40,47,55,56] A transverse or Richter incision may be used.[18,54]

The superficial fascia of the neck is a thin layer of areolar tissue which incorporates the platysma muscle. This thin muscular layer arises from the deep fascia over the pectoral and deltoid muscles and crosses obliquely upward over the side of the neck to insert into the body of the mandible and the fascia and superficial muscles of the lower part of the face. The platysma is innervated by the cervical branch of the facial nerve. The incision may be carried down to the platysma, the upper flap of skin being dissected up from the muscle;[30,31,56] however, usually the incision is carried through the platysma, the skin and muscle being dissected up as one piece.[8,17,19,26,27,40,47,55] In either case the upper flap should be dissected up to the notch of the thyroid cartilage. (Fig. 2.)

The external and anterior jugular veins lie in the superficial fascia deep to the platysma. The external jugular vein courses down over the sternomastoid muscle along a line drawn from the angle of the mandible to the middle of the clavicle. It receives the occipital, the posterior and external jugular veins and, piercing the deep fascia in the lower part of the posterior triangle of the neck, it receives the transverse cervical, transverse scapular and anterior jugular veins before terminating in the subclavian vein. The lateral ends of the incision come close to these veins. The anterior jugular vein passes down between the anterior edge of the sternomastoid muscle and the median line of the neck. It communicates with the common facial vein through a vein lying along the anterior border of the sternomastoid muscle. This communicating vein may be very large.[23] The anterior jugular vein receives tributaries from the inferior thyroid and laryngeal veins. It enters the suprasternal space of Burns where it communicates with the vein of the opposite side. Turning laterally the vein passes beneath the lower end of the sternomastoid muscle and ends in the external jugular or subclavian vein. (Fig. 3.)

The cutaneous nerves of the neck arise from the cervical plexus and curve around the posterior edge of the sternomastoid muscle near its middle. Piercing the deep fascia they are distributed to the skin of the neck and head. When it is desirable to use local anesthesia, these nerves are anesthetized by injecting the solution along the posterior border of the sternomastoid muscle.

DEEP CERVICAL FASCIA

The deep fascia of the neck is described as consisting of three main divisions, namely, the superficial or investing layer, the middle or pretracheal layer and the deep or prevertebral layer.

Anteriorly the investing (superficial) layer of the deep cervical fascia is continuous across the midline of the neck. Continued laterally it splits to enclose the sternomastoid muscle and

from the posterior edge of that muscle it is continued across the posterior triangle of the neck as one layer. Anteriorly the fascia passes up to become attached to the body and both

space contains the lower ends of the anterior jugular veins and their transverse communication. (Fig. 4.)

During thyroidectomy this layer of deep

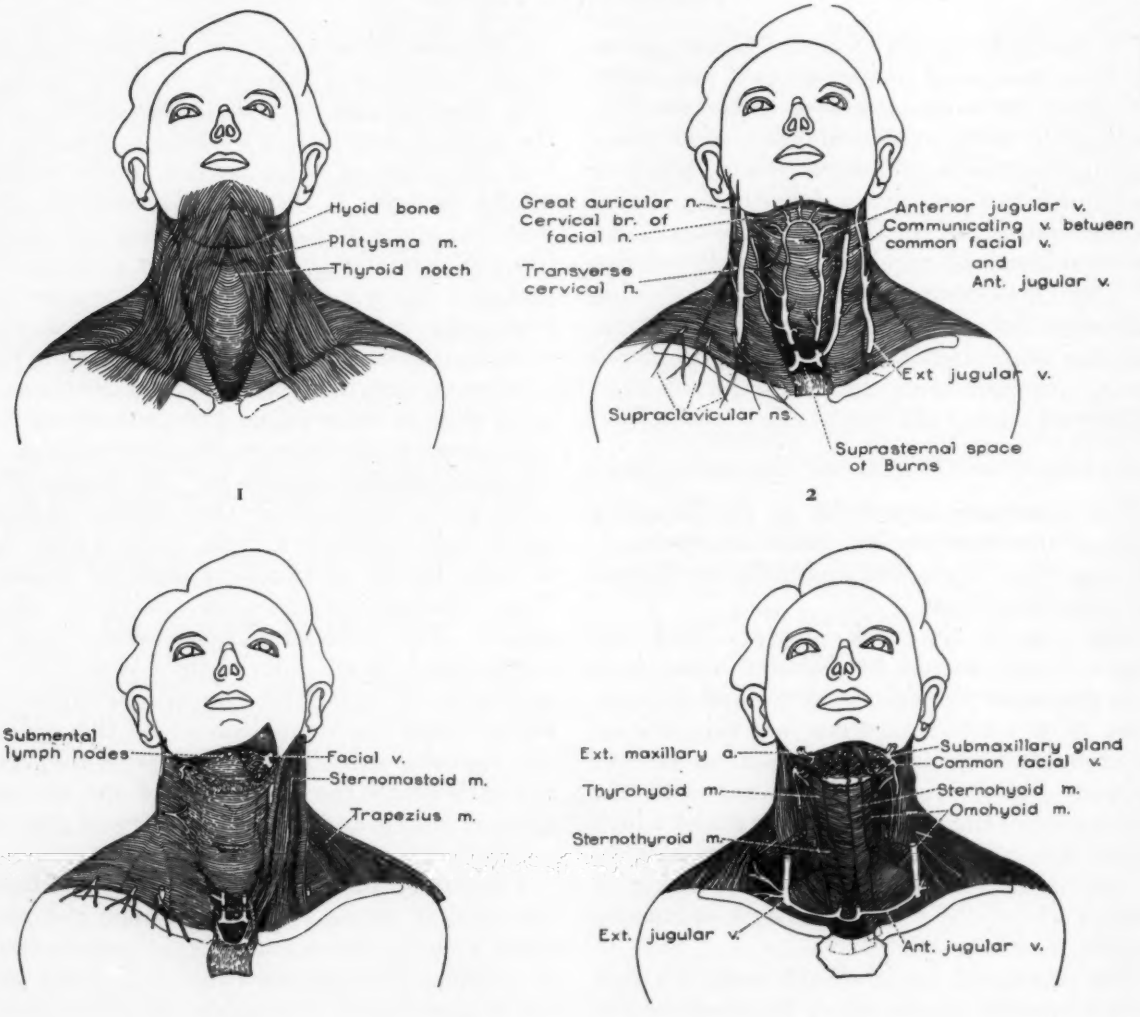


FIG. 1. The skin has been removed from the neck; the platysma muscle is seen extending over the side of the neck.

FIG. 2. The platysma muscle has been removed and the superficial fascia has been dissected off revealing the superficial veins and the cutaneous nerves; the suprasternal space of Burns has been opened to show the communication between the lower ends of the anterior jugular veins.

FIG. 3. The superficial veins and nerves have been partly removed; on the left side the investing layer of the deep cervical fascia has been incised and reflected over the sternomastoid and trapezius muscles and the submaxillary gland.

FIG. 4. The investing layer of the deep cervical fascia and the lower ends of the sternomastoid muscles have been removed; on the left side the superficial layer of the infrahyoid muscles in their investing layer of pretracheal fascia are shown; they have been removed on the right side (with the exception of the posterior belly of the omohyoid) to show the deep layer of infrahyoid muscles in their layer of the pretracheal fascia. The anterior jugular veins are shown ending in the lower parts of the external jugular veins.

cornua of the hyoid bone. Inferiorly it is attached to the manubrium and clavicles. It is split into two layers above the manubrium forming the suprasternal space of Burns. This

fascia is picked up and incised in the median line from the thyroid notch to the suprasternal notch. In the lower part of the incision the anterior jugular veins or their transverse com-

munication may be cut before they are clamped, permitting air embolism to occur. Seed states that air embolism is recognized by "ordering perfect quiet in the operating room, then listening for the telltale 'washing machine' sound. The sound can be quite audible and very disturbing to the operator without causing any observable untoward effect on the patient."

The sternomastoid muscle is the most prominent muscle of the neck. It separates the anterior and posterior triangles of the neck and covers the carotid sheath and its important constituents. The sternomastoid muscle arises from the manubrium and clavicle and inserts on the mastoid process and superior nuchal line. It is supplied on its deep surface by the accessory nerve and filaments from the second cervical nerve.

The middle or pretracheal layer of the deep cervical fascia invests the pharynx, esophagus, larynx, trachea, the thyroid gland and the infrahyoid muscles. The infrahyoid muscles are disposed into two layers. The superficial layer includes the sternohyoid and the omohyoid; the deep layer includes the sternothyroid and the thyrohyoid. Each layer of muscles has its own investing layer of pretracheal fascia continuous across and fusing in the midline. The fascia is especially thick in the triangle between the posterior belly of the omohyoid and sternohyoid muscles and the clavicle, where it binds the posterior belly of the omohyoid to the clavicle.

The layer of fascia enclosing the superficial infrahyoid muscles blends laterally with the carotid sheath; that investing the deep layer blends laterally with the carotid sheath and posteriorly with the false or surgical capsule of the thyroid gland. Lateral dissection between these muscle and fascial layers leads into the carotid sheath. (Fig. 5.)

The infrahyoid muscles are supplied on their deep surfaces by the first three cervical nerves through the ansa hypoglossi.

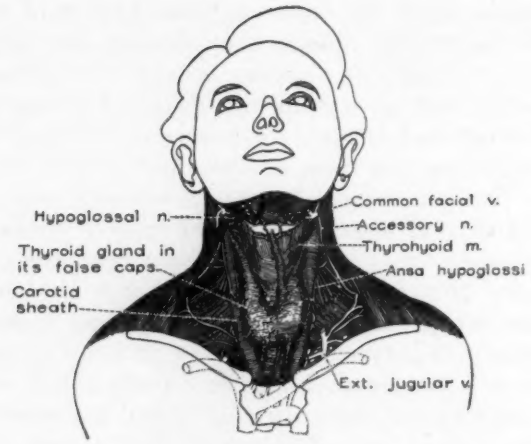
The sternohyoid and sternothyroid muscles are frequently cut transversely in order to expose the thyroid gland adequately. This should be performed across their upper parts not only to avoid injury to the nerves which enter the muscles in their lower halves but also to avoid having the line of closure of the muscles directly behind the line of skin closure.[4,26,30,39,40] Better exposure can also be obtained by incising the fascia along the lower anterior border of the sternomastoid muscle thus freeing the infrahyoid muscles to a greater extent.[26,30,40] Others prefer not to section the infrahyoid muscles finding that adequate exposure can be had by retracting the muscles laterally.[8,12,18,20,31,47,55,56]

The pretracheal faschia condenses around the thyroid gland to form the false or surgical capsule of that gland. The false capsule is separated from the true thyroid capsule by loose connective tissue in which the blood vessels ramify. It is pierced by the vessels entering and leaving the gland. The false capsule is best developed over the apex and lateral surfaces of the thyroid lobe. The parathyroid glands are usually buried in the false capsule posteriorly and, in the same area, the recurrent laryngeal nerve pierces the fascia and comes into intimate relations with the middle one-third of the posterior surface of the thyroid lobe.[2,20] The false capsule of the thyroid gland blends anteriorly with the sternothyroid muscle and its investing fascia. The value of cleaning the gland of this musculofascial layer in order to stay in the proper plane of cleavage (the surgical space) is stressed by most operators.[8,12,13,16,18,19,26,27,30,31,47,54,56] (Figs. 6 and 7.)

The carotid sheath is the fascial condensation around the internal jugular vein, the common and internal carotid arteries and the vagus nerve. The vein is lateral to the artery; the nerve is behind and between both. If one internal jugular vein is injured, it may be ligated without causing cerebral damage.[5,6,40,59] Ligation of a common or internal carotid artery causes death or hemiplegia in a large percentage of cases.[41,42] Section of one vagus nerve causes no serious cardiac or pulmonary complications but does result in unilateral vocal cord paralysis.[5]

THE THYROID AND PARATHYROID GLANDS

The thyroid gland develops as an outgrowth from the ventral wall of the pharynx. By the end of the seventh week of intrauterine life the thyroid gland has descended to the level of the larynx. The embryonic structure connecting the gland to its point of origin is the thyroglossal duct. The thyroglossal duct may fail to atrophy, persisting in the adult as a fistula, sinus or cyst.[53] The lower part of the thyroglossal duct is frequently represented in the adult as the pyramidal lobe of the thyroid gland. The thyroid gland may fail to descend, giving rise to a lingual thyroid.[22,44] Thyroid tissue may



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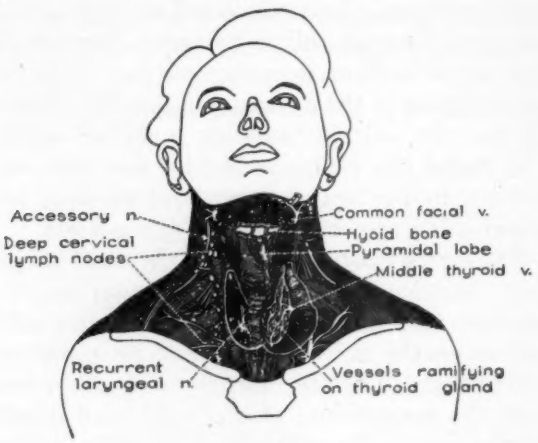

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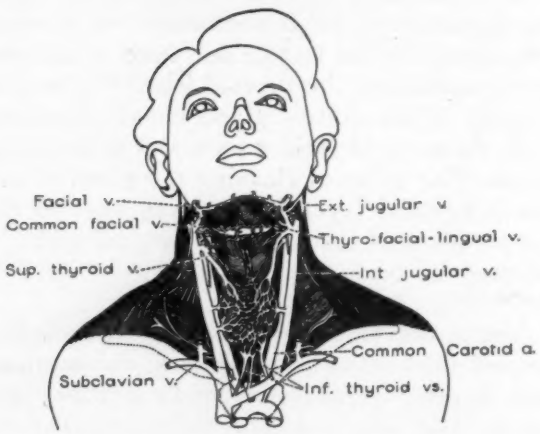

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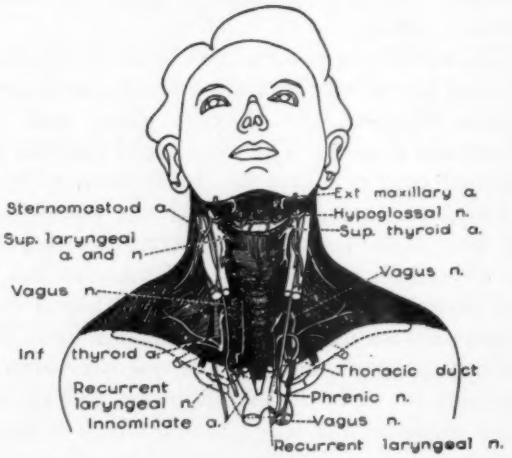

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FIG. 5. The infrahyoid muscles have been removed; the thyroid gland is seen to be invested by its false capsule; the close relationship of the carotid sheath to the thyroid gland is noted and lying on the carotid sheath is the ansa hypoglossi. Only the proximal ends of the nerves of distribution of the ansa are shown, as the distal ends have been removed with the muscles which they supplied, i. e., the infrahyoid muscles; the thyrohyoid muscle has not been removed.

FIG. 6. The false capsule of the thyroid gland has been incised and reflected; the right lobe of the thyroid and the right half of the isthmus have been removed. The vessels of the thyroid gland can be seen piercing the false capsule and on the right side the right recurrent laryngeal nerve is shown in relation with the branches of the inferior thyroid artery. The parathyroid glands are usually situated in this same area, the middle one-third of the posterior surface of the thyroid lobe. On the right side the deep cervical lymph nodes are illustrated.

FIG. 7. The false capsule of the thyroid gland (pretracheal fascia) and the carotid sheath have been dissected away; on the right side the superior thyroid vein ends in the internal jugular vein; on the left, in the common facial vein, helping to form the thyro-facial-lingual vein. On the left side the thyrohyoid muscle has been removed revealing the superior laryngeal vessels and the internal branch of the superior laryngeal nerve as they pierce the thyrohyoid membrane.

FIG. 8. The thyroid gland, the pretracheal fascia, the lower portions of the common carotid artery and the internal jugular vein have been removed; also the thyroid veins have been removed. The close relationship of the internal branch of the superior laryngeal nerve with the superior thyroid artery is noted. The vagus nerve, lying between and behind the common carotid artery and the internal jugular vein, is shown in the lower part of the neck. On the right side the inferior thyroid artery divides into its two main glandular branches behind the carotid sheath; on the left, closer to the thyroid gland. The right recurrent laryngeal nerve passes anterior to the main branches of the inferior thyroid artery and, accompanied with the inferior laryngeal artery, passes beneath the inferior edge of the inferior pharyngeal constrictor muscle; on the left side the nerve passes between the main branches of the artery. In the majority of the patients the recurrent laryngeal nerve passes behind the main branches of the inferior thyroid artery.

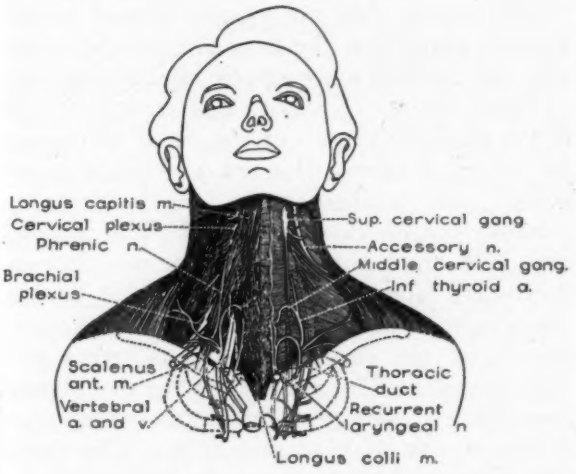
be left in the path of descent of the gland giving rise to adenomas anywhere from the foramen cecum of the tongue to the arch of the aorta.[38,43]

Small outgrowths from the fourth pharyngeal pouches called postbranchial bodies (lateral thyroid primordia, ultimobranchial bodies, suprapostcardial bodies) become incorporated in the lateral lobes of the thyroid gland and are thought to form true thyroid tissue.

There are two pairs of parathyroid glands, namely, one superior and one inferior behind each lobe of the thyroid. Parathyroids 3 (the inferior parathyroids) arise from the third pharyngeal pouches in close association with the thymus gland. They descend part way with the thymus gland and may be carried down into the chest with the thymus. Parathyroids 4 (the superior parathyroids) arise from the fourth pharyngeal pouches in association with the postbranchial bodies. They may become embedded in the thyroid gland with the postbranchial bodies.[9,10,49,51,54]

In the adult the normal thyroid gland presents two lobes joined across the trachea by the isthmus. A pyramidal lobe extending toward the hyoid bone may be present. Each lobe presents an apex, a base, a superficial, medial and posterior surface. The apex is limited above by the insertion of the sternothyroid muscle on the oblique line of the lamina of the thyroid cartilage. The base is on a level with the fifth or sixth tracheal ring. The superficial or antero-lateral surface is covered by the infrahyoid muscles. The medial or deep surface is molded on the larynx and trachea, the pharynx and esophagus, the recurrent laryngeal nerve, the cricothyroid and inferior pharyngeal constrictor muscles and the external branch of the superior laryngeal nerve. The posterior surface contacts the prevertebral fascia and overlies the common carotid artery.

The two lobes and the isthmus are firmly bound to the thyroid and cricoid cartilages by fascial bands or suspensory ligaments. The median suspensory ligament extends from the ventral surface of the thyroid cartilage to the dorsal surface of the isthmus. The lateral ligaments extend from the cricoid and tracheal cartilages to the medial surfaces of the lateral lobes of the thyroid gland. When the pyramidal lobe is present, a fourth ligament attaches this lobe to the hyoid bone. Before the thyroid



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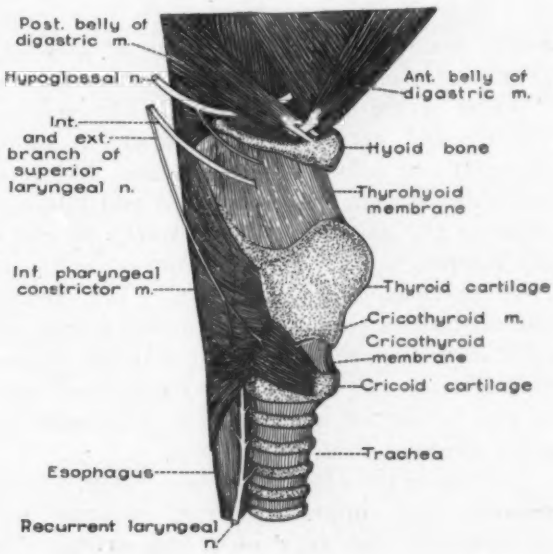

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FIG. 9. The common carotid artery and all of its branches, the internal jugular vein and all of its tributaries, the pharynx and esophagus, the larynx and trachea, and the suprahyoid muscles have been removed. On the left side the prevertebral fascia is shown. On the right side the prevertebral fascia has been removed revealing the anterior and lateral vertebral muscles, the cervical and brachial plexuses, and the contents of the vertebral triangle. On the left side the relationship of the inferior thyroid artery with the cervical sympathetic chain and the thoracic duct are noted.

FIG. 10. Lateral view of the larynx to show the position of the important nerves that could be injured during thyroidectomy.

gland can be freed from the larynx, these suspensory ligaments must be divided.[8,11,18,19,27,40,56] (Figs. 8 and 9.)

Injury to the trachea is avoided by careful dissection of the isthmus and division of the median suspensory ligament. Should the trachea be entered during thyroidectomy the rent should be closed with fine catgut and a drain left in the wound for several days postoperatively.[8,11,18,27,40]

Veins of the Thyroid Gland. The veins of the thyroid gland are the superior, middle (lateral) and inferior thyroid veins. The superior thyroid vein passes upward and laterally, crossing the common carotid artery to end in the internal jugular or the common facial vein (the thyro-facial-lingual vein). The middle vein(s) crosses the common carotid artery and ends in the lower part of the internal jugular vein. The inferior thyroid vein passes downward to end in the innominate vein. The veins are more irregular than the arteries.

Arteries of the Thyroid Gland. These are the superior and inferior thyroid arteries and, occasionally, the thyroidea ima artery. The superior thyroid artery arises from the external carotid artery and arching forward and downward breaks up on the apex of the thyroid gland into anterior and posterior glandular branches. Besides these glandular branches the superior thyroid artery gives off other branches, namely, the hyoid, sternomastoid, superior laryngeal and cricothyroid arteries as well as muscular branches to the infrahyoid muscles.

The inferior thyroid artery arises from the thyrocervical trunk of the subclavian artery, and it ascends behind the carotid sheath to the level of the cricoid cartilage where it turns medially and descends for about one-half of its ascending length. Turning forward the artery terminates close to the middle third of posterior surface of the thyroid lobe by dividing into an ascending and a descending branch to supply the posterior and lower parts of the thyroid gland. Other branches given off by the inferior thyroid artery are the ascending cervical, tracheal, esophageal and inferior laryngeal arteries. The inferior laryngeal artery accompanies the recurrent laryngeal nerve. The inferior thyroid artery presents many anomalies. It may be absent, it may branch into its two terminal branches while still behind the carotid sheath or it may ascend obliquely behind the carotid sheath to the back of the thyroid gland.[12,13,16,21,27,40] The cervical sympathetic chain embraces the artery as the latter turns medially.

The thyroidea ima artery when present arises from the innominate artery and ascends over the trachea to the lower pole or isthmus of the thyroid gland.

Nerves Related to Thyroid Gland

The nerves that are closely related to the thyroid gland are the branches of the vagus and the cervical sympathetic chain. (Fig. 10.)

Vagus Nerve. Near its exit from the base of the skull the vagus nerve gives off the superior laryngeal nerve. This nerve, while it is still behind the carotid sheath, divides into an internal and an external branch. The internal branch is much the larger of the two. It runs downward and forward on the side of the pharynx to the thyrohyoid membrane. Accompanied by the superior laryngeal artery and vein the internal branch pierces the thyrohyoid membrane and supplies the mucous membrane of the larynx with sensory fibers. The nerve also carried motor fibers to the interarytenoid muscle of the larynx.[3,16,48] This nerve is closely related to the superior thyroid vessels.

The external branch of the superior laryngeal nerve is the smaller of the two divisions of the superior laryngeal nerve. It is a long, slender filament that descends on the pharynx and passes between the medial surface of the thyroid gland and the larynx to supply the cricothyroid muscle of the larynx with motor fibers.

The recurrent laryngeal nerves are the main motor nerves to the intrinsic muscles of the larynx. The right recurrent laryngeal nerve arises from the vagus as it crosses over the subclavian artery. The nerve hooks around the artery and ascends in the neck near the tracheo-esophageal groove to pass beneath the inferior border of the inferior pharyngeal constrictor muscle and behind the articulation of the inferior cornu of the thyroid cartilage with the cricoid cartilage to enter the larynx. The left recurrent laryngeal nerve arises from the vagus as that nerve crosses over the left side of the arch of the aorta. Hooking around the arch of the aorta below the attachment of the ligamentum arteriosum the nerve ascends in the neck in the same manner as, but on a deeper plane than, the right recurrent laryngeal nerve. Rarely, the recurrent laryngeal nerve arises from the vagus higher in the neck and passes directly to the larynx.[52] In its course

up the neck the recurrent laryngeal nerve passes behind the lobe of the thyroid gland and behind, in front of or between the main glandular branches of the inferior thyroid artery. Fowler and Hanson dissected 200 bodies and found that in 65.5 per cent of the cases the recurrent laryngeal nerve passed posterior to the main branches of the inferior thyroid artery; in 26 per cent it passed anterior and in 8.5 per cent the nerve passed between the main glandular branches of the artery. These workers found that in practically 100 per cent of the dissections the recurrent laryngeal nerve was not safely tucked away behind the false capsule of the thyroid lobe but the nerve pierced the capsule and came to lie in contact with the middle third of the posterior surface of the thyroid lobe. Bachhuber after 100 dissections concurred with Fowler and Hanson's conclusions.

Cervical Sympathetic Chain. The cervical sympathetic chain passes down the neck behind the carotid sheath. The middle cervical ganglion is closely associated with the inferior thyroid artery.

SURGICAL SIGNIFICANCE OF THE VESSELS OF THE THYROID GLAND AND NERVES ASSOCIATED WITH IT

Mobilization of the thyroid lobe may be begun by dividing the middle veins.[2,13,30,40,55,56] Many surgeons prefer to begin at the superior pole of the thyroid lobe either by mass ligation of the superior thyroid artery and vein[4,8,12,18,26,54] or by individual ligation of the branches of these vessels on the apex of the lobe.[31] During this procedure one should avoid injury to the internal branch of the superior laryngeal nerve.[3,16,48] The external branch of the superior laryngeal nerve may be injured during resection of the lobe. Some workers prefer to begin the mobilization of the gland by elevating the base of the lobe and ligating the inferior thyroid veins.[27,31]

The treatment of the inferior thyroid artery is different from that of the superior because of the location of the parathyroid glands behind the lobe of the gland and the close association of the recurrent laryngeal nerve with the glandular branches of the inferior thyroid artery. Removal of the parathyroid glands results in tetany. Parsons and Purks reviewing 291 collected cases of total thyroidectomy found that in 10.3 per cent of the patients a transitory postoperative tetany had developed. If tetany does develop, medical treatment is available for it.[11,58]

Unilateral section of a recurrent laryngeal nerve usually manifests itself immediately by a change in or total loss of the voice, inability to cough and difficulty in swallowing. A speaking voice always returns. Bilateral injury to the recurrent laryngeal nerves is a much more serious accident. Not only is the voice lost but also the larynx is obstructed by the paralyzed vocal cords. This is manifested by stridor occurring at the time of injury or after the operation and may require an immediate tracheotomy. As the vocal cords atrophy, the voice tends to return but the laryngeal obstruction increases at the same time. Such a patient usually ends up with a permanent tracheotomy. Several operative procedures have been devised to help these people with bilateral abductor cord paralysis but none are entirely satisfactory.[34,35,37,57] In 1946 Kelly reported on fifty-four patients with bilateral paralysis of the abductor muscles of the larynx whom he had treated by removing one of the arytenoid cartilages with only five failures.

Lahey[38,40] dissects each recurrent laryngeal nerve free before he begins the resection of the lobe. Lahey[40] and Crile[12] isolate and ligate the inferior thyroid artery at a point proximal to its entrance into the thyroid capsule. Crile was unable to find the inferior thyroid artery in 6 per cent of his operations. This extracapsular ligation of the inferior thyroid artery was recommended by Crotti,[13] deQuervain[16] and Nordland.[74] These men believed that individual ligation of the glandular branches of the inferior thyroid artery close to the gland endangers the parathyroid glands and the recurrent laryngeal nerve. Hertzler,[27] an ardent exponent of total thyroidectomy, ligated the main glandular branches of the inferior thyroid artery close to the gland. He did not give his incidence of postoperative tetany or of injury to the recurrent laryngeal nerve. Hertzler[28] stated that in Kansas the parathyroids and the recurrent laryngeal nerves did not lie inside of the false capsule of the thyroid gland.

Most surgeons do not display the recurrent laryngeal nerves or the inferior thyroid arteries. Some men recommend that a search be made for aberrant parathyroids. In this connection Cope states, "The parathyroid glands are small, of a color hard to differentiate, in position various, and they are, therefore, found

only after painstaking search even at autopsy." Most surgeons avoid the danger zone by resecting the lobe over clamps so that a thin layer of thyroid tissue remains posteriorly in its capsule.[8,17–19,26,30,31,47,54–56]

Lateral extension of a thyroid tumor or operative procedures on the inferior thyroid artery are capable of injurying the cervical sympathetic chain, resulting in Horner's syndrome. The close proximity of the arch of the thoracic duct to the base of the left thyroid lobe should be kept in mind.

The prevertebral fascia forms a septum behind all of the aforementioned structures. This layer of the deep cervical fascia covers the anterior vertebral muscles and is continued laterally over the lateral vertebral muscles forming the floor of the posterior triangle of the neck. It covers the deeper structures of the vertebral triangle, the phrenic nerve as that nerve courses down on the anterior scalenus muscle, the brachial plexus and its supraclavicular branches and is continued beneath the clavicle into the axilla as the axillary sheath.

SUMMARY

Operations on the thyroid gland require an accurate knowledge of the anatomy of the region. The important structures that may be injured during thyroidectomy and the consequences of such injuries have been reviewed.

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TREATMENT OF THROMBOPHLEBITIS

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HUNTER, Sneeden and associates[35,36] in routine autopsies concluded that phlebothrombosis begins in the deep vessels of the calf and tends to propagate toward the heart. Of their later series, 52.7 per cent of 351 cases showed deep vein thrombosis. Among the aged the incidence was over 90 per cent. Fatal pulmonary emboli occurred in 3.13 per cent. In 45.5 per cent the fatal emboli arose from thrombosed leg veins. The fifth and sixth days of illness and again during the third week were the two periods in which the greatest number of fatal emboli occurred.

Bauer,[17] on the basis of phlebographic studies, stated that 98 per cent of all cases of deep thrombophlebitis of the legs begins in the calf and propagates toward the heart.

Barker and co-workers[11] reported the incidence of thrombosis and embolism to be 0.96 per cent and fatal emboli 0.2 per cent. Venous thrombosis and pulmonary embolism occurred twice as commonly following laparotomies done on female pelvic organs. The highest incidence of venous thrombosis and pulmonary emboli occurred following laparotomy with extensive resections. McCartney[42] and Crutcher and Daniel[21] reach much the same conclusion. All authors[11,12,24,26,27,54] agree that the incidence of thrombophlebitis rises sharply in patients fifty years of age and older. Fatal emboli occur more frequently in the sixth and seventh decades.

Because of improved preoperative care, more complete understanding of protein metabolism and more extensive use of blood transfusions, a greater number of patients, formerly considered poor operative risks, now are having surgery performed. Furthermore, this particular group of patients present the more debilitating diseases, such as carcinoma, in which the incidence of thromboembolism rises so sharply. The surgical procedures, too, are becoming more extensive. Neither is age any longer a deterrent to surgery. The result is that the frequency with which the older age groups are undergoing surgery shows a rapidly rising incidence. Thus thromboembolism is a disease confronting the surgeon more often. It is essential that this disease be guarded against completely if safe surgery is to be performed.

Our first aim in the treatment of thrombophlebitis should be the complete prevention of its occurrence. Once thrombophlebitis is established, attention should be directed toward: (1) preventing emboli to the lungs, (2) preventing extension of the thrombus, (3) removing congestion of the affected parts and (4) restoring function to as nearly normal as possible.

EARLY ACTIVATION

Reports in the recent literature have given an erroneous impression of the meaning of the term, early ambulation, and its relation to thrombophlebitis. Discussions have entailed only the unqualified and restricted sense of the term, usually meaning that the patient is allowed out of bed within seventy-two hours postoperatively without necessarily instituting adjuvant measures. Consequently, the confusion which has arisen regarding such therapy requires clarification.

Blodgett and Beattie,[19] in reviewing 681 cases, concluded that there is no support for the thesis that early ambulation reduces the incidence of thrombosis.

As the problem now is understood the term, early ambulation, should be discarded. "Early activation" of the patient better portrays what is meant. In this broader sense a definite series of therapeutic measures is included beyond that of getting the patient out of bed. Activation begins while the patient is still in bed and as soon as he has regained function of the extremities postoperatively. A vigorous program of active movements of the toes, feet, legs and modified quadriceps-setting exercises should be outlined to the patient. Oschner[51] has recommended the use of a board at the foot of the bed against which the patient may exert pressure.

Adams[1] has stated that energetic foot exercises, after proper instruction of the patient and nursing staff, resulted in a 50 per cent reduction in thromboembolic disease. Later in a study of the same groups of patients Evans and Boller[26] reported that three times as many fatal emboli

occurred among patients not exercising as among those who were exercising.

Bancroft and Stanley-Brown[10] emphasized factors which must be avoided while the patient is still in bed. They particularly stressed the necessity of maintaining unobstructed venous flow in the extremities. They pointed out that tight abdominal binders interfere with vena cava blood flow. The use of Gatch beds and Fowler's position produces constriction of the femoral vein at Poupart's ligament, which in turn is increased by flexion of the thighs and knees and the lower border of a tight abdominal dressing. The result is venous stasis in the entire extremity and an invitation to thrombosis.

The patient, when he is allowed out of bed often as early as the day of operation, should be walked. The patient is not allowed to exert himself getting in or out of bed. Dangling should be avoided. Once out of bed he is not permitted to sit in a chair. During the ensuing days the patient is allowed to walk further each day until he is completely ambulant. This is accomplished usually by the fourth or fifth days. To permit a patient out of bed at an early date following operation may be most harmful in certain cases. The indications for maintaining patients on continued bed rest are, therefore, particularly important.

Vaughn and his associates[51] have listed the following contraindications: (1) prolonged bed rest prior to surgery, (2) cardiac insufficiency, (3) recent coronary occlusion, (4) shock, (5) severe anemia, (6) hemorrhage or fear of hemorrhage, (7) suspected presence of thrombi or emboli, (8) suppurative conditions, (9) insecure anastomosis, copious tamponade and difficult hernia repair, (10) avitaminosis. (11) hypoproteinemia and (12) severe abdominal distention. The contraindications listed individually may vary with the patient and some elasticity may be allowed. Obviously, too, the list may be lengthened. However, a base line is established from which the surgeon may vary depending on his own experience and the condition of the particular patient.

SUPPORTIVE BANDAGES

Oschner[47] has stressed the importance of prophylactic bandaging, particularly for the older age group. Allen (5) has re-emphasized the important role that supportive bandages play in the prevention of chronic venous insufficiency following thrombophlebitis. The disappearance of edema is an important consideration in determining when the patient may abandon the use of the bandages. Three or four months are usually sufficient although considerably longer periods may be necessary in some cases.

RELIEF OF VASOSPASM

Ochsner and DeBakey[46,47] have stressed the importance of venospasm in the production of the clinical manifestations of thrombophlebitis. They are convinced that paravertebral lumbar sympathetic nerve blocks are of considerable value in preventing thrombosis. These authors also emphasize the role of tobacco as an agent in the production of venospasm. In their hands the results have been excellent.

DeTakats[23] reserves the use of paravertebral lumbar sympathetic blocks for those patients exhibiting marked venospasm as indicated by severe pain, a cold extremity and cyanosis of the toes. In other cases papaverine or other vasodilator drugs, elevation of the foot of the bed and heat to the abdomen provide results not inferior to those obtained by paravertebral lumbar sympathetic blocks. Furthermore, the maintenance of vasodilatation alone has been found insufficient to prevent or cure an acute thrombophlebitis. Clinics in the upper Middle West and in the East[8,28,38] have had much the same experience.

ANTICOAGULANTS

Heparin. According to Greene and Loewe,[31] heparin acts with plasma to prevent the conversion of prothrombin to thrombin. A strong antithrombin forms as the result of the combination of heparin with serum albumin. Heparin also inhibits the formation of thromboplastin from platelets.

Bauer[16] and later Loewe[41] have presented rather convincing evidence that the complete resolution of early clots is obtained with heparin. Loewe further demonstrated that the growth of collateral circulation is tremendously accelerated. Frequently I have noted that pain, even severe pain, usually is alleviated completely within one hour after the administration of heparin. Rarely does pain persist after a second injection.

The use of heparin is accompanied by few toxic manifestations. In some instances allergic phenomena have been reported. A rapid depression of coagulation time occurs, usually

within twenty minutes. When hemorrhage does develop, intravenous protamine is effective in a matter of minutes.[48]

The Mayo group[7,9,14,15] uses small doses (50 mg. every four hours). The Swedish authors,[17] however, have found that three or four intravenous injections of 100 to 150 mg. of heparin per day have given excellent results in the treatment of thrombophlebitis. In some clinics[28,38] it is thought that there may be an accumulative heparin effect to account for the apparently maintained antithrombic action.

In 1942 Loewe and associates[39] reported the use of heparin in Pitkin's menstruum. This menstruum is a combination of heparin, gelatin, dextrose and glacial acetic acid. But patients too frequently have complained of pain and a considerable amount of discomfort at the site of injection. More recently, Loewe and Hirsch[40] have reported that the menstruum now has been changed. The gel is carefully buffered, with the result that the pain factor has been completely overcome. The new menstruum is used as a deep subcutaneous injection.

Evans and Dee[27] reported the further use of heparin in Pitkin's menstruum. These investigators use the menstruum initially together with dicumarol.® When prothrombin time has been prolonged to adequate levels, heparin is discontinued.

The great advantage of the use of the menstruum is that heparin is released slowly. Although one dose of 300 mg. has been said by Loewe to give sufficient anticoagulant levels for two and even three days, some investigators[37,43] have found that the coagulation time is most variable and difficult to control. In addition, there is danger of obtaining a too prolonged coagulation time even with a single dose.

Dicumarol.® Apparently dicumarol® inhibits the catalytic action of vitamin K in the coagulation mechanism. The reversibility of this action is evident from the fact that the dicumarol® effect is quickly dissipated by the intravenous administration of adequate doses of vitamin K. The effect of dicumarol® is mainly on prothrombin. Other effects have been noted.[6] Clot retraction is retarded and the sedimentation rate of erythrocytes is increased. If larger doses are given, the coagulation time may be prolonged. A satisfactory prolongation of the prothrombin time is not apparent for forty-eight to seventy-two hours with the usual doses. Furthermore, the effect may last a week or more following its administration. A considerable variation in the sensitivity of patients is well established. Some will exhibit a markedly diminished latent period and will show a marked prolongation of prothrombin time up to two or more weeks with minimal doses of dicumarol.®

Bingham, Meyer and Pohle[18] reported that the therapeutic and fatal doses in dogs failed to produce significant pathologic changes in any tissues. They did note some capillary and venule dilatation. A few patients, however, will manifest allergic reactions, such as urticaria and headache.

In most clinics the initial dose is 300 mg., the second day 200 mg., and each day thereafter 100 mg. more or less depending on the prothrombin level. The prothrombin level should be determined each morning and no dicumarol® given until the level is known.

Prothrombin activity should be maintained between 10 and 30 per cent of normal in order to maintain adequate yet safe antithrombin levels.[6,7]

In cases of emergency, such as pulmonary infarction due to embolus, dicumarol® should be combined with heparin intravenously or heparin in Pitkin's menstruum. Both drugs are given together in the usual doses. When the effect of dicumarol® as measured by the prothrombin activity is adequate, heparin is omitted and the patient is maintained on dicumarol® alone.

In using dicumarol® it is particularly important to have satisfactory laboratory facilities available. In order to avoid disastrous hemorrhage, absolute control of the patient is necessary. Equally important is the necessity of regulating dosage so as to maintain an adequate antithrombic prothrombin level in order to avoid the complications for which anticoagulant therapy actually is instituted, namely, thrombosis.

Contraindications. Definite contraindications to the use of anticoagulants have been formulated by several groups of investigators:[4,7,9,24] (1) renal insufficiency, (2) brain and spinal cord injury, (3) blood dyscrasias, (4) ulcers, granulating wounds, (5) nutritional and vitamin C and K deficiencies, (6) hepatic disease, particularly associated with potential or actual prothrombin deficiency, (7) chest surgery, (8) hyperthyroidism, (9) excess postoperative bleeding, (10) arteriosclerosis in the elderly patient

particularly with hypertension, (11) arthritics using acetylsalicylic acid and (12) diabetes.

In addition, Quick[49] has pointed out that dicumarol® is contraindicated in pregnant women. He found that the prothrombin level in pups is reduced at birth although the return to normal levels occurs after the first few days of life. Pups born of mothers fed dicumarol® showed a greater reduction of prothrombin concentration than that of the maternal blood and several died of hemorrhage.

However, this situation apparently does not obtain in man or at least the effect is not as dramatic. Other investigators have safely given dicumarol® during pregnancy with no ill effect.[9] Nevertheless, one should be cautious in the use of anticoagulants in pregnant women.

VENOUS INTERRUPTION

Homans[33,34] provided surgical and anatomic proof of the beneficial effects of superficial femoral vein ligation. The technic consists of interruption of the superficial femoral vein just distal to the deep femoral vein, thrombectomy and exploration of the deep femoral vein. Iliac vein interruption was noted also to provide excellent collateral circulation. Vena cava ligation was advocated when necessary.

Collins and Nelson[20] recommend ligation of the ovarian veins also whenever iliac ligation is performed for pelvic thrombosis. Fine and Starr[29] advocated vena cava ligation in preference to ligation of both iliacs.

That vena cava ligation may be preferable to femoral or iliac ligation in certain cases is exemplified in the cases reported by Crutcher and Daniel.[21] In fifty-five autopsies performed on patients dying from embolism twenty-three presented thrombosis in the veins of the pelvis or upper abdomen, including renal, adrenal, ovarian and spermatic veins. In three cases thrombi were present in the right heart. The authors believe that vena cava ligation might well have salvaged several patients.

Edwards and Robuck,[25] as a result of their studies of the collateral circulation of the femoral vein, found that ligation distal to the deep profunda should give little or no venous obstruction since there are good anastomotic channels by way of the collateral femoral veins. It was pointed out that such ligation would fail to close the pathway of emboli in 10 per cent of cases since the lower deep femoral vein had gross communication with the femoral vein in 10 per cent of the limbs studied. Actually Donaldson[24] reports a 4 per cent incidence of emboli occurring in 1,587 cases in which venous interruption was performed. That disaster might follow ligation of the common femoral and saphenous veins was amply demonstrated in the case reported by Dennis.[22] Again, Edwards and Robuck demonstrated in their studies that with common femoral ligation disaster might well have been expected since a large amount of blood would be trapped, causing dilation and varices of the saphenous vein. The collateral veins undergo dilatation and become incompetent. Homans,[34] Allen[2] and others early pointed out the fact that following unilateral ligation emboli occurred too often. In such cases emboli had occurred frequently from the side not suspected of involvement, as proved later either by development of the full blown clinical picture of thrombophlebitis or at autopsy. They, therefore, recommend bilateral superficial femoral vein ligation.

During the past four years several authors have reported series of cases in which vena cava ligation was performed in an effort to get completely above the area of thrombosis and obviate any opportunity for embolism. Northway and Buxton,[45] in 1945, described the extensive collateral circulation occurring when vena cava ligation is performed. They reported ten cases. Gaston and Folsom[30] reported two cases in the same year and Veal and Hudson[53] reported six cases. Moses,[44] in 1946, reported twenty-one cases with nine deaths. Thebeault and Ward[50] reported thirty-six cases with four deaths. Moses has listed the following indications for ligation of the inferior vena cava: (1) thrombophlebitis of the pelvic veins and pulmonary emboli; (2) pulmonary embolism associated with recent prostatic tenderness, especially with deep tenderness along the anterolateral wall of the rectum; (3) reasonably conclusive evidence of pulmonary infarction, the source of which remains obscure despite diligent search; (4) venous occlusion of the lower extremity that would otherwise be treated by interruption of the femoral vein alone, as in lymphangitis, cellulitis, infections of the groin and large tender nodes of the groin; (5) recurrent emboli following bilateral ligation of femoral veins; (6) femoral phlebothrombosis with tense edema extending above the knee; (7) operative findings of an adherent clot on exposure of the femoral

vein and (8) acute thrombophlebitis extending into the upper thigh clinically, with the presence of pulmonary embolism.

Thebault and Ward in some respects carry their argument in favor of vena cava ligation even beyond that of Moses. They prefer this operation to that of femoral or iliac ligation because, they contend, that emboli may still occur after such ligations. They claim that ligation of the inferior vena cava is the treatment of choice particularly for patients who already have had pulmonary emboli. They prefer to use the anticoagulants as a supplementary treatment to prevent extension of the thrombotic process.

As yet, too few cases are reported for statistic analysis and the reported operative mortality is too high. Yet within a few years this may well be the operative treatment of choice. Certainly in femoral thrombosis that has extended into the iliac veins and in pelvic thrombosis, particularly in recurrent cases, vena cava ligation is deserving of serious consideration.

COMMENTS

In the prevention of thrombophlebitis, early activation, wide use of supportive bandages and avoidance of tobacco both pre- and postoperatively are extremely important. There is a definite place for the use of paravertebral lumbar sympathetic blocks and antispasmodic drugs in selected cases.

The anticoagulants and venous ligation are the most effective means at our disposal for the prevention and treatment of thrombophlebitis. However, a great problem arises as to what type of treatment is best suited to the individual patient. A comparison of the results of treatment with anticoagulants[9] and ligation[25] reveals that anticoagulants offer the patient a wider margin of safety. Furthermore, it is well to bear in mind that venous interruption has no place in the treatment of acute thrombophlebitis after the seventh day of the disease unless pulmonary emboli have occurred.[3] It should be understood that the danger of pulmonary emboli is minimal in a full blown thrombophlebitis in that the thrombus is adherent to the wall of the vein. Pulmonary emboli are most apt to occur when there is Homans' bland thrombosis[32] or Ochsner's plebothrombosis.[46] Barker[13] prefers to consider plebothrombosis and thrombophlebitis as belonging to the same disease process, simply interpreting phlebothrombosis as the subclinical stage of the disease. However, there are several groups of patients who require special consideration and make decision difficult.

A survey of reported series reveals that the incidence of thrombophlebitis among the younger age groups is very low. It is quite another matter in considering the older age groups. An increasing incidence of thromboembolism occurs with advancing age, the highest incidence of fatal emboli being in the sixth and seventh decades. Among the latter group, must be considered those who are physiologically aged, patients with chronic debilitating diseases, such as cancer, ulcerative colitis, regional ileitis, intestinal obstruction and chronic severe suppurative diseases. In these conditions there is a tendency toward venous stasis and subsequent formation of thrombi. Here the possibility of a fatal embolus is an ever pressing problem.

In patients under forty, the incidence of thromboembolism is very low. These patients are difficult to restrain in bed and they do exercise freely. Definitive exercises in bed should be the rule. No other preventative measures need be considered unless extensive surgery or repeated surgery is contemplated. In the latter event it will be well to employ anticoagulants along with early activation. A history of previous thrombophlebitis is another indication for the prophylactic use of the anticoagulants in this group.

When a patient already has an acute thrombophlebitis, this condition should be treated with anticoagulants. If an elective procedure is contemplated, the patient should be allowed to recover completely. Only then should surgery be contemplated. At the time of surgery the patient should be started on anticoagulants, preferably dicumarol.® In the event that thrombophlebitis occurs during the postoperative period, anticoagulants are indicated.

If the patient has a second episode of thrombophlebitis, the wisest course is to perform bilateral femoral ligation. The indicated surgery may then safely follow. Bilateral femoral ligation is particularly advisable in emergent surgery. When surgery is elective, there may be some argument for the anticoagulants; but recurrent thrombophlebitis may become acute at any unpredictable period, particularly following a surgical procedure. Some delay is inevitable before anticoagulants can be administered because of the danger of hemorrhage.

During this interval a fatal embolism may occur.

An entirely different approach to the problem is necessary with patients over forty or patients physiologically aged regardless of actual age. These patients are in the age group in which the incidence of venous thrombosis is sufficiently high to cause one anxiety for the life of every operated patient. There is no question that prophylactic treatment has its greatest application here.

Anticoagulant therapy should be instituted prophylactically in all patients of this age group. It is particularly important among those patients undergoing herniorrhaphies, gallbladder, gastrointestinal or pelvic surgery, and those suffering chronic debilitating diseases or intestinal obstruction. To fail to institute such therapy is an injustice to the patient.

The advisability of venous interruption must be strongly considered in certain categories of this group. The anticoagulants fail to afford maximum protection against thromboembolic disease among the aged and among those patients for whom long term hospitalization and repeated operative interference is contemplated. Ligation is the wiser choice. The anticoagulants may be used as an adjuvant to surgery if embolism does occur.

If the patient presents himself with a primary acute thrombophlebitis with no antecedent history, he may be treated with anticoagulants if elective surgery is contemplated. Surgery should then be postponed until the acute exacerbation is subsided completely. In some cases surgery can be performed and anticoagulants again instituted following surgery. However, the older the patient and the more extensive the surgery contemplated, the greater chance the patient has of suffering a pulmonary embolism which may be fatal. Since it is not uncommon for emboli to occur during the first seventy-two hours following surgery and since anticoagulants cannot be used sufficiently soon to provide a safe antithrombic level in less than forty-eight to seventy-two hours, a fatal embolus may occur before a safe antithrombic level is reached. This complication could be avoided by venous interruption prior to or at the time of surgery.

Still another point must be made in favor of venous interruption for those patients advanced in age especially in the group with a history of thromboembolism or who are to undergo extensive surgery. Barker and his group[11] have reported that if a non-fatal embolism has occurred, the chances of a subsequent non-fatal or fatal embolism is 30 per cent. This is a formidable figure.

The responsibility of the surgeon does not stop when the patient leaves the hospital. In the advanced age group illness requiring varying periods of bed rest is not infrequent. For those patients with an antecedent history of thromboembolism the possibility of a new thromboembolic episode always exists after the patient has been discharged from the hospital. Certainly it is not advisable to treat these patients at home. We can protect them from a possible accident at home by performing venous interruption while the patient is in the hospital.

Special consideration must be given patients with thigh amputations and those for whom anticoagulants are contraindicated. Veal[2] has shown that mortality from emboli following thigh amputation is as high as 42 per cent. The incidence was lowered to 17.5 per cent when prophylactic superficial femoral vein interruption was performed. Ligation was preferred over the anticoagulants because: (1) hematomas which may follow the use of anticoagulants can seriously impede wound healing in the stumps. Healing is usually notoriously poor in any case since this group usually contains the arteriosclerotic and diabetic patients; (2) the procedure is innocuous, quickly performed and prolongs the surgical procedure by only a few minutes. At the same time immediate protection of the patient is provided. On the other hand, it would be unsafe to use anticoagulants during the first three days.

Patients for whom anticoagulants are contraindicated are those at home or hospitalized in an institution where laboratory facilities are unsatisfactory for the proper evaluation of antithrombic levels. Obviously, when treatment is indicated and contraindications to anticoagulants exist, one should resort to venous interruption.

SUMMARY

In the surgical patient the primary source of pulmonary embolism is thrombophlebitis of the deep veins of the calf. At the present time the incidence of thrombophlebitis in postoperative cases is about 1 per cent. Among postoperative cases 11 per cent of fatalities are due to thromboembolic disease.

The prevention of thrombosis is the important factor in reducing fatalities. Among the prophylactic measures to be used are: (1) early activation, (2) wider use of supportive bandages, (3) avoidance of tobacco pre- and postoperatively, (4) use of anticoagulants whenever indicated and (5) venous interruption when indicated.

To prevent embolism in established thrombophlebitis, mild heat and elevation of the extremities together with the use of supportive bandages are helpful. If a vasospastic factor is present, the use of paravertebral lumbar sympathetic nerve blocks and papaverine are indicated. Depending upon the particular case, anticoagulants or venous interruption are indicated. In a few cases both venous interruption and anticoagulants are recommended.

Interruption of the vena cava is an important contribution to the treatment of thromboembolic diseases. As yet the number of published cases is too small to warrant its general use. It may be, however, that this operation will prove to be valuable in selected cases.

Sufficient data are now available to permit definite conclusions to be drawn regarding whether the anticoagulants or venous interruption are to be employed in a particular case. An attempt has been made to indicate which is the procedure of choice in the different categories of patients.

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AMBULATORY THERAPY FOR THROMBOPHLEBITIS WITH RUTIN AND VITAMIN C

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THE purpose of this communication is to discuss the more modern concepts of etiology and treatment for thrombophlebitis and to present the writer's clinical findings on this topic, along with his observations in three similar cases, with the use of a rutin preparation and ascorbic acid.

In 1939 Ochsner and De Bakey first used the term phlebothrombosis and distinguished it from thrombophlebitis,[1] which is caused by infectious inflammatory damage to the intima of the vein. The thrombus in thrombophlebitis is firmly attached to the wall of the vessel. Phlebothrombosis occurs very often in postoperative cases, and its thrombus is detached easily from the intimal wall of the vein. Phlebothrombosis is said to occur frequently in those patients who require prolonged bed rest, and this may produce an increase in venous stasis and alterations in the cellular and fluid blood elements.

It appears to be a difficult task to distinguish between phlebitis alone and phlebitis with thrombus formation,[2] for probably some thrombus formation is present in nearly every case. Foot[3] claims that acute inflammation of the veins is almost always associated with extensive thrombosis. This thrombus may become detached and become an embolus, and today the consensus follows Ochsner's thesis that such a thrombus is more likely to be a phlebothrombus, which may produce symptoms none other than tachycardia and possibly embolism. Thrombophlebitis, on the other hand, very frequently produces edema, pain and fever. Furthermore, it is usually harmless so far as the possibility of embolus formation is concerned, except when red coagula form at the proximal end of the thrombus, or if suppuration happens to be present.

Meyer[4] states that the diagnosis of phlebitis and thrombophlebitis of the deep veins of the leg can be accomplished by palpating the suspected veins when the leg muscles are relaxed. When the aforementioned conditions are present, the involved vein is tender and sensitive to pressure (Homan's sign) at the calf of the leg when its muscles are put under tension. Normal healthy veins do not produce pain when pressure is applied to them. Boyd[5] adds that a thrombosed vein "feels hard like a chord."

Liebow[6] claims that the most serious complication of thrombophlebitis is the release of a large embolus to the lung. He states that postmortem examinations show far more emboli, which reach the lung, than are ever suspected clinically. These do not usually produce a significant effect upon the pulmonary parenchyma in the absence of chronic passive congestion in the lungs, or if the thrombus does not carry bacteria, which it usually does not. He claims that the thrombus is attached to the vessel wall within a very few hours. Hence only very recently formed clots are likely to be released into the venous circulation. He states that it is rare for a fatal embolus to have its origin there for these fatal pulmonary emboli are usually derived from the deep femoral system.

Meyer[4] has written, "As the venous congestion is the principal factor which prevents the elimination of the infection from the veins, the customary method of treating phlebitis is useless, because it does not attack the venous congestion. Removal of the venous congestion is the *conditio sine qua non* for a cure of peripheral phlebitis.

"In the customary treatment of phlebitis, the patient is confined to bed for a long period of time with the leg fixed in an elevated position. All that can be accomplished by the rest cure is a temporary improvement, but never a cure. Unless the venous congestion in the legs is removed, a cure is impossible. For this reason the anticoagulant therapy has not been very successful in the treatment of thromboses and in the prevention of embolism. In treating phlebitis of the legs two purposes must be achieved at the same time. One is to cure the phlebitis by removing the venous congestion.

The other is to prevent the detachment of a blood clot. Both purposes are achieved by the use of pressure bandages."

Robb[7] recommends the elastoplast bandage, and he also mentions that the tissues around the phlebitic area can be infiltrated. This diminishes pain to a surprising extent and hastens resolution. (Note this with respect to one of the author's case reports which is to follow.)

Shute et al. advocated alpha-tocopherol acetate (vitamin E)[8] for the treatment of thrombophlebitis and phlebothrombosis in their series of twenty-two patients. They recommend about 200 to 300 mg. of alpha-tocopherol per day as the average therapeutic level.

Green and Loewe[9] described a series of 251 patients with venous thromboembolic disease who were treated with the Pitkin menstruum with gratifying results. These authors observed fifty-three patients who exhibited all forms of venous thromboembolic disease. These patients were also treated with the heparin/Pitkin menstruum. Patients with uncomplicated thrombophlebitis and/or phlebothrombosis were treated for ten days to two weeks. They employed papaverine parenterally and orally. Smoking was prohibited. They wrote that, "Paravertebral block, although used extensively in arterial occlusions, was not used by the writers in thrombophlebitis as a routine measure since they have found that venous spasm disappears promptly following the administration of subcutaneous heparin."

Urschel et al.[10] in discussing the heparin and dicumarol® technics state that these methods require constant attention and prolonged experience. "The main objectives are the difficulty of control and the danger of hemorrhage in postoperative patients."

Kushlan[11] reported the successful treatment of hemorrhagic telangiectasia with intestinal bleeding in a fifty year old male. Rutin was used in 40 mg. doses three times daily. This medication seemed to control the bleeding in this case which was discussed in another publication.[12]

Since rutin seems to act similar to a vitamin P material, it appears to be most useful in the treatment of a number of hemorrhagic conditions, such as experimental histamine and anaphylactic shock,[13] experimental frostbite,[14] experimental irradiation injury,[15] hypertension[16] and in various conditions of the eye.[17,18]

Hence it occurred to the writer to investigate the possibilities of rutin in combination with ascorbic acid in the treatment of thrombophlebitis. Since the intimal portions of the veins seem to suffer injury, a short review of their histology seems in order.

Jordan[19] states that the wall of the larger veins resembles that of the corresponding artery. The venous wall is thinner and contains far less elastic tissue. The tunica intima of the medium and large veins presents a lining endothelium, a thin layer of delicate connective tissue fibers and an incomplete internal elastic membrane. Jordan writes of certain atypical veins, such as the common iliac, femoral and saphenous veins which contain small longitudinal muscle bundles in the intima. Although Jordan does not make a particular point of this occurrence of muscular tissue in the intima, it would seem that this element is present because of the undue stress to which these veins may be subjected. Hence it follows that trauma and infection in such areas would be more apt to occur. Nature has, therefore, provided this additional muscular element as an additional protection against such agents.

Purpuric spots and patches may occur concomitantly with or even without frank thrombosis of the venous lumen. Such areas of purpura may be well due to diapedesis which in turn may be partially or wholly due to increased capillary fragility.

The writer has found such evidence to exist by means of a rather simple test which he used. Any surface of the body is struck a sharp blow with the examiner's open hand. In the course of a few minutes the area, struck in such a manner, becomes visibly reddened in a pattern which covers only the slapped area. Patients with normal capillary function do not usually show such a phenomenon. Although this is but a rather crude test for the presence of capillary fragility, it appears to be a very simple and useful clinical diagnostic procedure.

Miller[20] believes that, "It is possible that in a mild rutin and ascorbic acid deficiency the structure of the endothelial lining of the veins may be weakened or changed in such a way that a set of events follows which result in thrombophlebitis." It goes without saying that some sort of an endothelial change must occur to make it possible for an otherwise normal vein to become subject to thrombus formation, for normal veins do not form thrombi.

Hodges and Freeman[21] call attention to the fact that there is inflammation of the vein walls in phlebothrombosis (non-inflammatory venous thrombosis) and frank inflammatory-ilio-femoral thrombophlebitis or phlegmasia alba dolens. Both of these clinical conditions, according to these writers, show inflammatory changes. However, the matter of the degree of involvement seems in their opinion to be the main differentiating point.

If the endothelium is changed by such an inflammatory process, it becomes clear just why an increased capillary permeability occurs.

Best and Taylor[22] have written that, "When the main veins leading from a part are obstructed by new growth, fibrous tissue, as in cirrhosis of the liver, thrombosis, etc., increased transudation of fluid occurs. This is due in part to the rise in intracapillary pressure but the permeability of the capillary wall is also increased as a result of the impaired blood supply, or as in the case of a new growth, probably to the production of toxic substances as well."

These same investigators have written that in inflammatory edema several factors combine to produce the fluid infiltration of the tissues. Increased capillary pressure occurs due to dilatation of the vessels and local slowing of the blood stream as well as to thrombosis and obstruction of the returning veins. The lymphatics for a variable distance from the inflammatory area are obstructed as well. The capillary walls are also seriously damaged by the bacterial toxin or other injurious agent, so that a fluid with a high protein content escapes from the vessels. The edema is localized to an area of varying extent surrounding the injured site.

Ochsner and De Bakey[23] have written that patients with postphlebitic edema which is due to vasospasm, "should avoid those measures which produce vasoconstriction, such as smoking and exposure to cold, and should avoid becoming emotionally upset. They are instructed to use compression applied before arising in the morning either by elastic bandages (ace No. 8, lastex) from toes to the knee or by elastic stockings. We prefer the bandages, because although an elastic stocking is easier to use and is slightly less objectionable to the patient as regards its appearance, it has the disadvantage of stretching and not fitting properly in a few days. Even though the elastic bandage (ace No. 3) similarly stretches, it is applied daily to conform to the size of the leg that particular day."

Applying pressure in the form of either "ace" bandages or elastic stockings is really a substitute for venous compression which these diseased veins are incapable of doing themselves. Hence applying such elastic supports is vasoconstricting this particular leg area. In other words, here we strive to vasoconstrict these diseased venous areas by mechanical means. I prefer the elastic stockings, for if applied properly and with care, stretching is reduced to a minimum and the unbroken elastic threads can conform to the size of the legs daily. The patient's involved leg is raised above the level of the hips for fifteen minutes. Then massage, with the strokes being started at the peripheral aspect, pushes the pooled blood towards the groin. This assists in collapsing the dilated veins. When these diseased veins appear collapsed and flattened, only then is the elastic stocking applied with the patient remaining with the involved leg elevated. If this "milking process" is not followed, there is great danger of crushing and further damaging the greatly dilated veins by the added pressure from these elastic supports.

CASE REPORTS

CASE 1. A white male, forty-four years old, had a large varicose vein on the calf of his left leg. This varicosity had its inception as the result of the patient's participation in athletics while attending a university. The patient had desired to follow his physician's advice and submit to thrombosing the vein, but he had neglected to do so throughout the years.

The patient drove about 1,900 miles in his car within a period of four days. This varicosed vein area had rubbed continually on the seat as he drove. He was seized with a rather sudden pain in that area. This forced him to cease traveling and stop at a hotel. He reported great pain and extreme effort in getting out of his driver's seat, since he could not put any weight on the affected leg, much less step with it or move it. Examination revealed a cord-like thrombosed venous area at the area of the varicosed site of the left leg. Even light pressure applied there caused excruciating pain. This leg was swollen down to the ankle and foot. The patient was put to bed with the involved leg elevated and with a heat pad

applied to it. An opiate was given to control his pain.

The next day little improvement was noted, but this patient insisted upon driving to his home. With great effort he arrived at his destination, where an ace elastic bandage was applied with the involved leg placed in an elevated position, with a heat pad applied.

The patient, however, insisted upon attending to his work; and although he wore the ace bandage continually for two days, the pain in the involved leg became so severe that he had to stop his work and return to bed. The leg was markedly swollen after the compression bandage was removed.

At this period of treatment it was thought advisable to treat the intimal portion of the involved venous area. He would not consent to surgical measures so a rutin preparation* was prescribed. The patient ingested two tablets three times daily following meals.

The results obtained were rather startling. After a day's treatment the patient could stand on his leg. Furthermore, the application of the ace roller bandage could be tolerated without undue pain, and the patient returned to his work. Although he limped considerably, he remained at his office the entire day.

Within two days' time, with this therapeutic regimen, he did not use the elastic support. He was free from pain and swelling in the thrombosed vein area. Even light palpation of that area failed to elicit a painful response. He slept comfortably at night, which was something he had not experienced since the onset of his difficulty. He continued to work daily without further hindrance, and he apparently made a speedy recovery. Examination of the previously involved area a month later indicated complete absorption of the thrombosed area.

At the time of this writing, a year later, he had not experienced any return of his previous difficulty.

Case II. Mrs. W., age thirty-five, white, reported great pain, discoloration and swelling of the left leg for a year and a half. She had been receiving injections in the previously multiple thrombosed varicose veins of the left leg and ankle areas sometimes twice daily. The patient frequently sprayed these painful areas with ethyl chloride in an attempt to control the pain. She had not submitted to any surgical procedure previously.

Examination of the involved areas, after the removal of her elastic stocking which she wore continually while upright, showed multiple areas of discoloration, induration and marked swelling. These areas were exquisitely tender to very slight digital pressure.

The previously described rutin preparation was prescribed in an identical manner, and the elastic stocking was reapplied in the usual elevated position. She reported two days later and stated that she had experienced practically no pain since she began this therapy. Subsequent treatment produced the further elimination of leg swelling and induration at the thrombosed sites. The discoloration was eliminated, and she returned to her teaching position without any further difficulties. She remained free from her trouble for a period of six weeks.

Case III. Mrs. D. G., age twenty-seven, white, complained of leg varicosities, with excruciatingly tender areas in both legs, with generalized swelling and discoloration. This condition had been present for about six months, and she finally felt unable to perform her housework and care for her two small children.

Elastic stockings were applied with the patient's legs in the elevated position. Care was taken to ascertain that the veins were in a collapsed condition before the stockings were rolled into place. The aforementioned therapeutic rutin regimen was prescribed with the patient ingesting two of these tablets following each meal.

One day later the patient reported her ability to be about without the recurrence of her previous pain and swelling of the involved areas. Examination a week later showed marked generalized improvement which had continued until this writing a month later.

SUMMARY

The adequate treatment for thrombotic involvements of varicosed veins should include the use of medications which assist the involved areas by repairing the intimal damage which results in such cases. The combination of rutin with ascorbic acid apparently assists these diseased areas to recover, for the observa-

*This rutin preparation carries the following formula: rutin 20 mg., ascorbic acid 150 mg. and calcium citrate 0.25 gm. It is marketed under the name of "Rucevitin" and is prepared by the Kremers-Urban Company of Milwaukee, Wis.

tions in this limited series of cases eliminated the omnipresent induration, swelling and painful areas with discoloration without fail in a remarkably short period of time. Each patient was able to return to work when he was treated with this therapeutic preparation, along with the use of elastic stockings, in order to collapse the diseased venous areas.

The economic aspect of such therapy is an important factor for each patient, for an early return to his or her duties is a decided advantage if such will prove to be proper in future observations.

Although this series of cases is, indeed, small in number, the results obtained seem to be worthy of reporting. It should be stressed that this therapy certainly is not meant to supplant other methods for treating such conditions. Rather, this method should be considered as merely a therapeutic adjunct which might prove worthy of further intensive clinical observations.

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THREE FUNDAMENTAL PRINCIPLES OF HAND SURGERY*

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THE dangers of scar contractures across flexion creases have been recognized by hand surgeons for many years. Since Kanavel's classic work on hand infections first appeared, considerable attention has been paid to the location and direction of incisions for drainage. As a consequence flexion deformities have been pretty well avoided in those types of cases. Unfortunately, much less emphasis has been directed toward the proper placement of incisions and scars in cases which required repair of large surface defects.

Scars occurring in the long axis of fingers nearly always cause contracture deformities. In the palm these scars may also cause contractures or they may otherwise contribute to loss of hand function by the formation of hard, raised tender cords. This article is intended to review three simple principles which when used materially improve the postoperative results obtained in hand surgery.

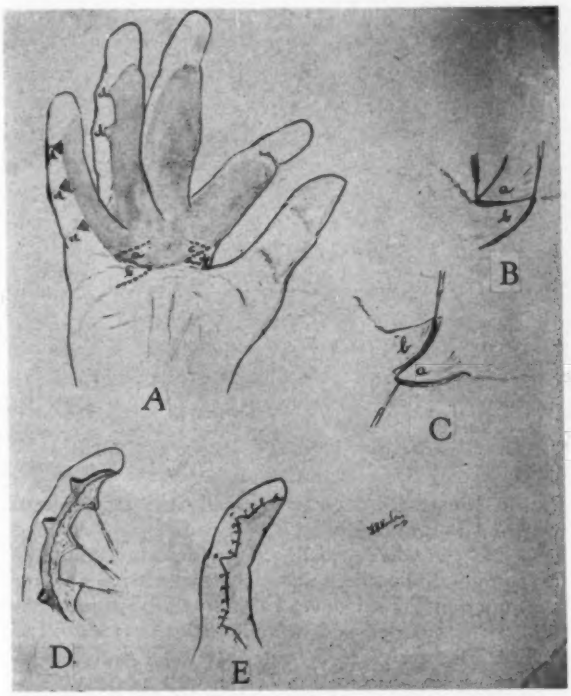

FIG. 1. Diagram illustrating two of the principles described in the paper. A, *d*'s represent the area of darts. The charted lines show the areas of good skin removed at the joint creases. The fourth finger of this illustration shows how the pedicle flap is drawn into the dart in the form of a V and so prevents contracture. This is also illustrated in D and E. The principle of the Z-plasty is shown in B and C. In B the Z incision is made and flaps are undermined. In C the flaps are transposed, reversing the direction of the Z. The practical application of these principles is illustrated in the diagrammatic A where the pedicle goes against the lines.

FIG. 2. Photograph of the patient's pedicle showing darts placed at the creases and showing the small Z performed in the palm of the hand to prevent contracture. The palm Z's are the reverse flaps as illustrated in Figure 1A.

Z-plasty. When scar contractures are present and when adequate local tissue is available, Z-plasties may be utilized to correct the deformity and to break up the scar line. This procedure is very ancient. Szymanowsky credits Denonvillers with modern use of the method but the method is said to have been referred to

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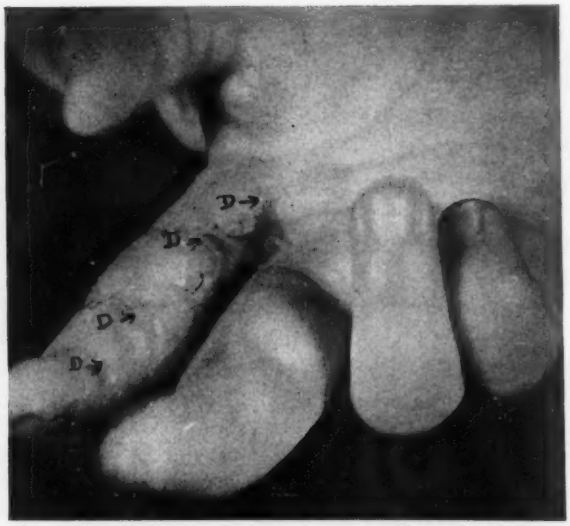

FIG. 3. Photograph of a patient who had had a severe contracture of the forefinger following the corrections of a web space and the failure to use darts. The reconstruction excised the contracture scar and split skin grafts were placed at the medial sides of the fingers with darts being inserted on the volar side wherever the joint creases were present. The D's point to the darts.

by Hippocrates. The technic of Z-plasty is well known and has been adequately described in many textbooks. Its utilization is illustrated. (Figs. 1 and 2.) It should be added that Z-plasty has a great field of usefulness in the prevention of linear scars as well as in their correction.

Dart Principle. At times it becomes necessary to resurface fingers and hands by the use of either free or pedicle grafts. Such circumstances may arise from excision of scars or tumors, burns, avulsion wounds, Dupuytren's contracture or congenital anomalies such as syndactilism.

If in such cases the junction lines between healthy skin and grafted skin extend across flexion creases, the resultant contractures are just as serious as those occasioned by other types of scarring. It is well to note that even when the scar lines are placed on the sides of the fingers as they certainly should be, the linear contracture interferes with function. In such cases darts should be used. Darts consist of tongues of graft which extend beyond the margin of the remainder of the suture line into previously prepared beds. These tongues or V's of tissue are constructed at each flexion crease and they effectively break up the straight line. They should be used even though normal skin has to be excised to form their bed. (Figs. 1 and 3.)

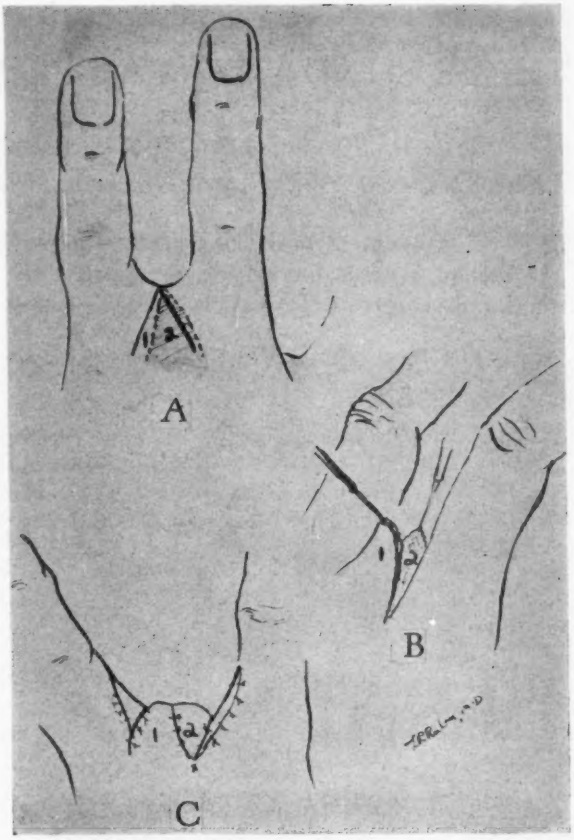

FIG. 4. Illustrates diagrammatically the principle of repairing web spaces. The dorsal pedicle 1 is outlined as well as the volar pedicle 2. It is important that the insertion is carried high up to the metacarpal phalangeal junction. At this level an arch will be found containing the blood vessels which go to the sides of the fingers. This arch can be very carefully stretched to allow as great a correction of the web as possible. B and C show the flaps being transposed to form a big Z deep in the base of the web.

Interdigitated Flaps. Suitable web spaces are essential for the proper function and normal appearance of a hand. The use of interdigitated flaps to construct these spaces has been emphasized by many outstanding surgeons. This method to some extent resembles a combination of the dart and the Z-plasty and yields end results which are far superior to simple, free grafting of the web space region. (Figs. 4 and 5.)

A case which demonstrates all three of the aforementioned principles is presented herewith. The highly pigmented flap presents an excellent color contrast for the illustrations.

CASE REPORT

M. W., a twenty year old Negress, was admitted to Kings County Hospital on March 11, 1947, with third degree burns of the right hand

incurred in an industrial accident two hours before admission. She was treated with 70 per cent cod liver oil pressure dressings which were left in place for seven days. Thereafter dressings were removed daily and a program of active motion in a warm saline hand bath was instituted.

Twenty days following injury all slough had separated and the flexor tendons of all four fingers were exposed, lying in a bed of healthy granulation tissue.

On April 2, 1947, granulations were excised from the burned area. An abdominal flap was raised and sutured to the lesion on the hand. The donor area on the abdomen was covered with a split skin graft. Immobilization was maintained by a plaster of paris jacket.

On April 23, 1947, the flap was delayed by an incision and resuture across the base. On April 30, 1947, the hand was released from the abdomen, the edge of the flap was sutured to the hand, web spaces were constructed and the fingers separated. In four succeeding operations done at six-week intervals the flap was thinned by excision of excess fat, darts were reconstructed and the web spaces deepened. Z-plasties were also done on the palm at the ends of the transverse suture lines.

The patient had an excellent functional result.

In this case a pedicle flap was used because of the exposure of flexor tendons and the need for palmar fat pad. The removal of excess fat provided the extra skin needed for the darts.

SUMMARY AND CONCLUSIONS

Three principles of great value to the hand surgeon have been reviewed. A case has been presented illustrating the use of all three principles, namely, darts, Z-plasties and interdigitated flaps.

FIG. 5. This illustrates a healed web space showing the two flaps made by the transposition.

Although the case presented utilized a pedicle flap, the principles are equally as important when split skin grafts are used.

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SURGICAL TREATMENT OF HERNIA IN THE AGED*

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HERNIA in the aged is a common occurrence. With advanced age the elastic fibrous tissue of the fascial and muscular layers of the abdomen undergoes a gradual transition to a more plastic and less resilient tissue, predisposing to herniation and accentuating heretofore less conspicuous hernias. By the same token, cure of such hernias becomes a more difficult task. For many years there has been debate concerning medical versus surgical treatment of hernia in the aged. Advocates of the former have maintained that the risk involved and the recurrence rate did not warrant operative treatment. This survey is the result of an effort to ascertain the proper indications for and the results of surgical treatment of hernia in the aged.

This is a review of 142 unselected cases of various hernias in aged patients admitted to the wards of the Mount Sinai Hospital between 1941 and 1947. The age of sixty was arbitrarily set as the minimum for this study. The youngest patient was sixty and the oldest ninety-eight, with an average of 66.7 years. The greater proportion of these patients, 109 (76.7 per cent), were males, many of whom were gainfully employed.

ANALYSES OF CASES

Sixty-nine patients in this series were operated upon as acute surgical emergencies because of recent incarceration with the production of symptoms ascribed thereto; forty-eight patients were operated upon electively. The remaining twenty-five patients underwent no operation because of various contraindications to elective surgery. (Table 1.)

In the urgent cases, although concomitant diseases were frequent, time-consuming preparation for operation was impossible. Whenever time allowed, such complications as dehydration, acidosis, azotemia, cardiac decompensation and pneumonia were combated with appropriate measures. The elective cases, however, were carefully appraised with respect to complicating factors and their effect upon the outcome of the proposed operation. It has been the general attitude at this hospital that age *per se* is no contraindication to necessary surgery.

In Table 1 are shown the complications for which surgery was contraindicated. In two cases age was given as the only reason; it was considered contributory in three others. In evaluating the eventual outcome the complicating diseases are weighed regarding both their risk to life and their effect on recurrence. Cardiovascular disease exemplifies the former, prostatic hypertrophy the latter. Such diseases as bronchitis and obesity may be risks in either phase. Hypertension *per se* is no contraindication to operation; only complications therefrom such as cardiac failure, renal failure and cerebral thrombosis and hemorrhage prohibit surgical intervention. There were twenty-two cases which were complicated by hypertension; eighteen of these patients were operated upon electively. The manometric readings in these patients varied from 160/95 to 210/110. Such patients were carefully studied to determine cardiac reserve, kidney function, vital capacity and any organic or functional change which might contraindicate elective surgery.

TABLE 1
CONTRAINDICATIONS TO REPAIR (TWENTY-FIVE PATIENTS)*

Hypertensive cardiovascular disease	8
Generalized arteriosclerosis and debilitation	8
Small asymptomatic hernia	7
Chronic bronchitis	5
Severe obesity	3
Age	5
Prostatic obstruction	3
Patient refused operation	2
Myocarditis	1
Bronchopneumonia	1
C.N.S. Lues	1

* Multiple complications in several cases.

The importance of close observation before and after operation by the internist cannot be emphasized too strongly. Surgeons must coop-

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erate to the utmost when dealing with aged individuals to see that the physician is able to detect and treat fully any pre- or postoperative complications.

Male patients are examined rectally and catheterized for residual urine even in the absence of urinary symptoms. If there is urinary retention, the cause must be eliminated before hernioplasty is performed. Hypertrophied prostates, urethral strictures and bladder stones are dealt with by the urologist before elective surgery is contemplated. Markedly obese patients are delayed from operation until weight reduction has progressed to satisfactory levels. Thirty-three per cent of our cases had no preoperative complications. The remainder were fraught with multiple diseases mostly cardiovascular in nature.

The type of anesthesia is determined individually for each patient. General anesthesia is preferred and well tolerated by the patient who has no complicating factors and by the hypertensive. Local anesthesia is employed on patients with respiratory, severe cardiac and other systemic diseases, especially in urgent cases in which careful preoperative study cannot be done. Low spinal anesthesia is useful in the presence of respiratory disease, obesity and intestinal obstruction. It is attended by unwarranted risk in hypertension and cardiac disease. General anesthesia was used in fifty-five cases, local anesthesia in forty-six and spinal anesthesia in twenty-one.

In selecting the operative procedure of choice the frequent mitigating circumstances encountered in patients of this type must be considered. Those patients suffering from systematic effects of severe strangulation and incarceration, as well as those with concomitant diseases which threaten life, must be subjected to the simplest procedure compatible with relief from the presenting emergency. This may consist of merely dividing a constricting fascial ring or it may be necessary to resect gangrenous bowel followed by simple closure of the wound without attempt to obtain a plastic cure. In five instances bowel resection with primary anastomosis was undertaken whereas in two additional cases exteriorization of the bowel without anastomosis was necessary due to the precarious state of the patient on the operating table. There were seven cases in which simple release of the incarceration followed by closure without repair was deemed adequate, as it was thought that definitive surgery at the time would jeopardize the patient.

Definitive surgery is employed in elective cases as well as in those urgent cases in which the general condition of the patient justifies more meticulous dissection and repair. In indirect hernias the sac is ligated as high as possible and closure is effected by the so-called Ferguson technic (suture of the aponeurosis over the cord). In those cases containing a direct component, however, the procedure after sac ligation is identical with that employed for direct hernia. This is the same as the modified Wyllys Andrew repair described by Iason.[1] That is, the attenuated transversalis fascia is plicated and followed by suture of the aponeurosis to the inguinal ligament transplanting the spermatic cord into the subcutaneous tissues. When the internal ring is defective, purse string suture of the defect in the transversalis fascia is performed. In this series no fascial transplants were employed.

When the bladder is involved in a direct hernia, our usual practice either is merely to reduce the viscus and close fascia over it or to plicate the bladder wall followed by fascial closure; we do not resect the "redundant" bladder as described by Iason. Sliding hernias are frequent in the aged and these are treated using the Hotchkiss method (suture of the sac about the inturned viscus in such a way as to create a mesentery from the coaptation of the edges of the peritoneum). In ten cases the spermatic cord was resected; in an additional ten this procedure was accompanied with a primary orchidectomy. Two of the former were followed by infection and necrosis of the testis requiring secondary orchidectomy. It is not our intention to discuss this moot subject at length, but it is suggested that if the scrotal attachments of the testicle remain undisturbed the cord may usually be resected with impunity. Our indications for such resections are recurrent or large scrotal hernias with poor fascial structures. There were no recurrences in our patients who were so treated. Multiple hernias are operated upon at separate sittings.

Femoral hernias are repaired by the universal method of subinguinal approach employing a high ligation of the sac and suture of the inguinal ligament to Cooper's ligament. If intestinal resection is necessary, this is accomplished through the original incision, if feasible, or the incision may be continued upward by

dividing Poupart's ligament. On occasion a separate abdominal incision is utilized in order to obtain more exposure for resection.

Umbilical hernias are repaired using the usual Mayo technic of overlap. Incisional hernias are similarly treated with overlap suture of the fascia. In recent years early ambulation has been practiced by those patients whose general condition permits.

TABLE II
POSTOPERATIVE COMPLICATIONS

Wound infection	8
Minimal	4
Severe	4
Requiring orchidectomy	2
Pneumonia	4
Hematoma	3
Cardiac failure	2
Phlebothromobisis (with pulmonary infarction)	1
Pulmonary atelectasis	1
Urinary retention	1

In Table II are summarized the postoperative complications encountered. There is a 6.5 per cent over-all postoperative infection rate; this includes two cases of necrosis of the testicle following cord resection. (Disparity in the sums of hernias and of patients is due to a multiplicity of hernias in several patients.)

TABLE III

	Cases	Follow-up (6 mo. to 5 yr.)	Recurrence	Recurrence Rate (per cent)
Inguinal	..	..	..	....
Indirect	48	33	3	9.9
Direct	26	16	3	18.8
Recurrent	11	7	0	0.0
Femoral	22	10	3	30.0
Umbilical	5	3	0	0.0
Recurrent umbilical	1	1	0	0.0
Incisional	9	5	1	20.0
Total	122*	75	10	13.3

* Multiple hernias computed individually.

In Table III are shown the follow-up and recurrences. The follow-up constitutes 67.5 per cent of the hernias for which operation was performed, exclusive of the fatal cases. An over-all recurrence rate of 13.3 per cent in a series of patients whose average age is over sixty-six years does not seem prohibitive in the light of higher recurrence rates usually found in much younger patients.[2] Less strenuous activity in the aged may account in part for these favorable statistics. We heartily concur with Grace and Johnson that there is a great disparity in the anatomic and symptomatic results for in only two of our recurrences were there subjective complaints. The remainder were discovered rather than presented.

In Table IV is a summary of the eleven fatal cases in each of which the patient was operated upon as an emergency. Scrutiny of this summary reveals several instructive features. In only one of the eleven cases (No. 3) can we reasonably state that the patient died from a cause entirely unrelated to the incarcerated hernia. In the ten others it is evident that the patient died either as a complication of the urgent condition or because this acute episode was the precipitating factor to an already debilitating chronic disease. It appears that, with the tenuous hold on life which exists in an elderly patient whose coronary arteries are markedly sclerosed, sudden trauma to the intestine with attendant pain, dehydration and obstructive phenomena necessitating immediate anesthesia and operation places too great a burden on the organism as a whole. Although it is conjecture, we may reasonably conclude that since most of these patients died as a result of the acute episode previous elective surgery, following adequate preparation, might have been life-saving.

There were no deaths in the elective cases. The mortality rate in the urgent cases was 15.9 per cent.

COMMENT

It is our policy to disregard chronologic age in considering patients for operation. The importance of disturbed physiology and complicating diseases is given more weight, and the decision to operate is one which must be shared by the physician as well as the surgeon. Indications for operation on hernia in aged patients are as follows: previous incarceration, scrotal hernia, local discomfort, urinary or bowel symptoms which may be ascribed thereto, or increasing size of the hernia. As has been stated, hypertension is not a contraindication to operation. It must be determined by the internist, however, whether or not the hypertension is complicated by marked organic

TABLE IV
SUMMARY OF FATAL CASES

Chart No.	Sex	Age	Location	Pathologic Condition	Complications	Anesthesia	Procedure	Course	Autopsy	Cause of Death
470000	F	65	Umbilical	Strangulated ileum with perforation	General peritonitis; chronic bronchitis	General	Closure of perforation	Shock; died 24 hr.	+	Peritonitis
499738	F	70	Femoral	Gangrenous ileum	Coronary sclerosis	Local	Resection and anastomosis	Leaked from anastomosis; shock; died 11 da. postoperatively	+	Peritonitis
483333	F	66	Direct inguinal	Strangulated bladder and ileum (viable)	Hypertension; arteriosclerosis	Local	Surgical reduction	Early recovery; died suddenly 16 da. postoperatively	+	Cerebral arterial thrombosis
498502	M	70	Indirect inguinal	Strangulated ileum (viable)	Shock on admission	Spinal	Simple repair and orchidectomy	Remained in shock; died same day	+	Shock
483029	M	76	Indirect inguinal	Strangulated ileum (viable)	Hypertension; chronic bronchitis	Local	Simple repair with resection of cord	Slowly downhill; died 17 da. postoperatively	−	Bronchopneumonia*
478398	M	86	Indirect inguinal	Strangulated ileum (viable)	Hypertensive cardiovascular disease	Spinal	Simple repair	Shock in operating room; died 1 hr. later	+	Shock
472767	M	60	Recurrent indirect inguinal	Gangrenous ileum	Admitted with pulmonary edema	Local	Exteriorization of bowel	Remained in shock; died 6 da. postoperatively	+	Shock and coronary occlusion
491040	F	60	Incisional	Gangrenous transverse colon	Peritonitis; coronary sclerosis	Spinal	Exteriorization of bowel	Shock on operating table; died 12 hr. later	+	Shock and coronary occlusion
540149	M	82	Direct inguinal	Strangulated ileum (viable)	Hypertensive cardiovascular disease	Local	Simple surgical reduction	Operation followed by heart failure	+	Arteriosclerotic heart disease (CA. of stomach discovered at necropsy)
543160	M	65	Incisional	Strangulated ileum (viable)	Complete obstruction due to hernia	Spinal	Simple reduction	Signs of intestinal obstruction continued; died in 2 da.	−	Intestinal obstruction*
550641	F	76	Femoral	Gangrenous ileum	Arteriosclerotic heart disease	Local	Resection and anastomosis	Progressive heart failure; died 9 da. postoperatively	−	Cardiac failure*

* Clinical impression.

structural changes. By wider application of elective surgery in the aged we shall be able to diminish the number of emergency cases which, in poorly prepared elderly patients, are attended by a high mortality rate.

CONCLUSIONS

1. Neither advanced age nor uncomplicated hypertension is a contraindication to elective hernial repair.

2. The indications for operation are essentially the same in the aged as in younger patients.

3. The risk of operation as an emergency procedure may be obviated by elective surgery following careful preoperative evaluation and preparation by internist and surgeon. This is substantiated by our analysis which demonstrates a mortality rate of 15.9 per cent in the urgent cases and no deaths in the elective cases.

4. A recurrence rate comparable to that in younger individuals indicates the value of surgery in the aged.

5. The results cited here should encourage medical men to consider elective surgical therapy for hernias in the aged more commonly than is now done.

Acknowledgment: The author wishes to express his gratitude to Dr. Ralph Colp and Dr. John Garlock for permission to report cases from their surgical services.

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CARCINOID TUMOR OF THE SMALL INTESTINE

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DESPITE infrequency of occurrence, carcinoid or argentaffin carcinoma is one of the most interesting tumors of the small bowel, especially with regard to the question of its malignancy. Although this growth is most often found in the appendix, it is encountered next most commonly in the small intestine, particularly the ileum. A case occurring in this latter site is the subject of this report.

CASE REPORT

A. J. P. (No. 5868), a white male aged fifty, was admitted to the Nazareth Hospital on June 14, 1942. His chief complaint was "pain in the stomach" (indicating the epigastric and substernal regions). The patient had had indigestion for years but during the present attack had an almost constant pain in the upper abdomen, which was worse after eating. Vomiting also occurred after eating heavily, especially of fried or fatty foods. He was constipated. No bloody or black stools were noticed. Since the onset of severe indigestion six months prior to admission he had lost 35 to 40 pounds. Systemic review added nothing further, nor did the past medical, family or social histories.

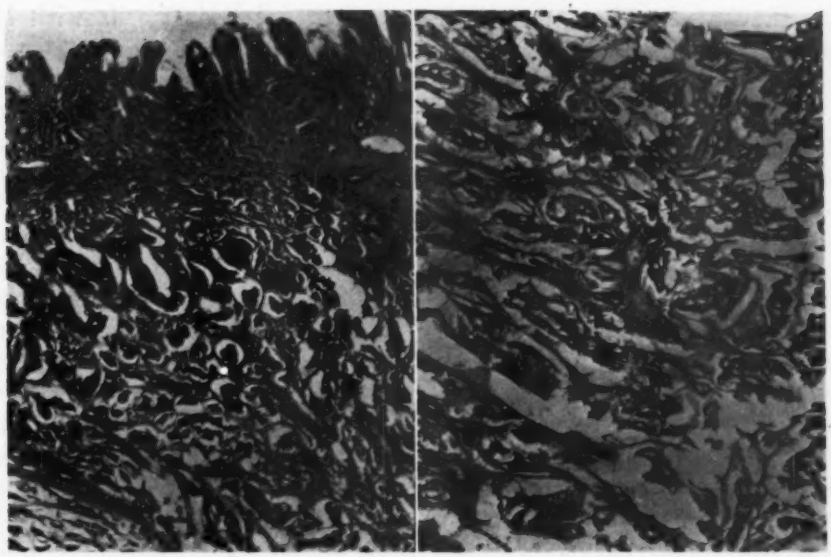
The positive physical findings were one spot of tenderness above and somewhat to the right of the umbilicus "at about the location of the pylorus" and slight abdominal rigidity. No masses were felt.

Urine and blood studies gave normal findings; x-rays were made and a prepyloric niche-deformity was a constant finding. After 5 hours the barium was mostly "distributed through the terminal ilium and colon as far as the hepatic flexure." Barium enema demonstrated multiple diverticula in the descending colon and sigmoid. Gallbladder x-ray was within normal limits. In summary, the roentgenologist thought that a gastric ulcer was present, possibly malignant.

With this same thought in mind, operation was planned. The patient was prepared; he was given 500 cc. of blood and was operated upon June 19, 1942. Under continuous spinal anesthesia an upper left rectus incision was made. The stomach, pylorus and duodenum were found to be perfectly normal. The liver, however, showed several buff colored nodules measuring approximately 5 to 10 mm. in diameter. About 18 inches proximal to the ileocecal valve the ileum showed a hard, annular, pale, constricted area. For approximately 6 inches to either side of constriction the serosal surface of ileum was dark red in color with grayish mottling, with many dilated lacteals. This section of ileum was thickened and unusually indurated.

A resection of the involved bowel and the subjacent mesentery was done, going several inches beyond the indurated bowel on either side of the lesion so that about 3 feet of intestine were included. A side-to-side anastomosis was then carried out and the abdomen closed. The patient had a smooth convalescence and was discharged two weeks later.

The pathologic report was as follows: Grossly, the specimen consisted of a loop of small intestine with mesentery measuring 110 cm. in length. Forty centimeters from one end there was an indurated area on the free border which puckered the serosal surface. On section there appeared to be an exceedingly indurated, raised area, which was pink and apparently ulcerated, measuring 3.5 by 2.3 cm. Upon transverse cutting it appeared well delimited to the submucosa but a similar-appearing area surrounded the invaginated serosa. Proximal to the lesion the bowel wall was edomatous and thickened and the lumen was dilated. In the mesentery there was an indurated area 2 cm. in diameter around which there was a tendency to contract. The mucosa of the proximal bowel was very edematous and covered with yellowish mucoid material. The distal bowel segment was rather dark red and non-edematous and the wall thin and lumen normal. The overlying serosa was purplish. This lesion almost entirely obstructed the lumen but the small finger



1 2

FIG. 1. This section of the primary tumor shows the characteristically intact overlying mucosa, the firmly packed, well defined, solid clumps or strands of small polyhedral cells, the presence of part of the tumor in the submucosa just below the depth of the mucosal crypts (upper right) and the extension into the muscularis with the production of much dense fibrous tissue.
FIG. 2. This view shows a more marked fibrosis in the outer portion of the tumor confirming the clinically constricting character.

could be forced through between the lesion and that part of the mucosa not involved.

Microscopically, over the tumor area proper, the mucosa and its villi were more or less intact except for superficial minor interruptions in continuity. Immediately subjacent and extending to the entire depth of the section were numerous compact cellular aggregations. The cells were round and quite equal in size and staining reaction. The cells were smaller than epithelial cells. The nuclei, however, were all hyperchromatic. In the muscularis they pushed apart and infiltrated the surrounding tissue causing some distortion of the cells themselves. In the center of some of the aggregations, especially the large ones, there were rounded and ovoid areas, apparently formed by the cells themselves, imparting a glandular pattern. These might have been lymphatics and were devoid of erythrocytes. In the section from the mesentery, the general picture was similar but the cells appeared to be more irregular, in some areas spindle-shaped, more deeply staining and more destructively infiltrative. The wall of the proximal bowel loop revealed marked edema and hypertrophy. (Figs. 1 and 2.)

The diagnosis was (1) carcinoid of the small bowel (ileum) with secondary tumor in the mesentery and (2) partial chronic intestinal obstruction.

The patient has had no complaints since discharge. Since that time he has gone to a family doctor at infrequent intervals but only to have "health certificates" filled out because he works in a restaurant.

When re-examined on March 25, 1948, the patient stated that over the years his health was good, especially his digestion, and his bowels moved daily. He had gained weight and maintained it. During the month before re-examination he had had some indigestion and upper abdominal distress. Physical examination showed a well healed abdominal scar. There was a sense of resistance in the epigastrium, but no tenderness or definitely outlineable mass was found. The patient was advised to return to his doctor to arrange for x-ray studies but did not do so. One month later he was again free of symptoms. (Two years more have elapsed and he is still well.)

COMMENTS

Carcinoid tumors of the small bowel merit discussion on the basis of their rate of occurrence, but more practically on the question of

whether or not they are malignant and, if malignant, to what degree.

Incidence. As Raiford's[1] excellent study of necropsy and operative specimens at Johns Hopkins Hospital points out, in 62,000 cases there were but twenty-nine carcinoids of the small intestine. The case herein reported is the only one on record at the Nazareth Hospital in 8,451 similar specimens. One other case was recently found at operation at the Germantown Hospital.

The incidence of carcinoid in relation to other small bowel tumors, however, is not nearly so insignificant; an average of reported figures puts it at one of every six. For example, Dockerty and Ashburn[2] at the Mayo Clinic in a study of 132 tumors of the small bowel found that 30 or 23 per cent were carcinoid. Other studies from various clinics[3–7] bring the average to 17.5 per cent or one of every six tumors found in this portion of the intestinal tract.

All writers agree that carcinoid tumors are found most often in patients in later middle life (fifty-five to fifty-eight years average) and that males are predominantly affected.

Patbology. Grossly, the appearance may vary. "Young tumors usually take the form of nodules or plaques projecting into the bowel lumen and covered by intact mucosa. As they enlarge they may show central umbilication or ulceration. Older growths, especially solitary ones, may encircle the bowel and cause infolding of the muscle coat and stenosis" (Willis[3]). Ewing[8] writes of the tumors as "small, firm, yellowish, circumscribed nodules from 0.5 to 1.0 cm. in diameter situated in the submucosa and muscularis, covered with smooth mucosa and thickened peritoneum. Larger tumors may protrude into the gut or peritoneum or encircle and constrict the lumen or infiltrate the surrounding tissues. Occasionally they are multiple." An example of the constricting type has been cited in our case. The case at the Germantown Hospital was that of a small, solitary, yellowish nodule. Pennington and Priestly[14] describe a multiple type lesion, one in which 52 inches of small bowel containing sixty-eight tumors of the carcinoid variety were removed.

According to Willis[3] these tumors are "histologically so distinctive that they can be identified readily without using the somewhat fickle silver staining test." He describes them as typically consisting of "well defined solid clumps or strands of rather small, closely packed, polyhedral cells with here and there small glandular lumina or distinct acini. The more actively growing tumors show varying degrees of anaplasia in part or whole." Again he says, "Microscopic study reveals that even small well defined tumors have often sent fine extensions into the muscular and serous coats; as this infiltration extends it may cause dense fibrosis of the tissues and may be accompanied also by apparent hyperplasia of the invaded muscular tissues." These characteristics (small, closely packed cells forming pseudo-glandular patterns and invasion of the deeper layers of the bowel wall with fibrous tissues response) were present in our case at Nazareth Hospital.

Ewing[8] observes that the uniform size, regular position, opacity and lack of hyperchromatism indicate moderate malignancy, and recalls the features of low grade melanoma or basal cell carcinoma. Our sections exhibited these details but did show hyperchromatism. This indication of moderate malignancy is not restricted to histologic interpretation for by its tendency to spread and metastasize the lesion behaves as a truly malignant tumor.

Raiford[1] found metastases in 20.7 per cent of his cases. Pennington and Priestly[9] found such an incidence of metastasis of 25 per cent. Stewart and Taylor[10] collected eighteen cases of the metastatic variety. Reynolds and Cantor[11] found the incidence of metastases varying in the reports from 18.3 to 52 per cent. In our constricting lesion and in the solitary tumor (Germantown Hospital) liver metastases were present. The metastases like the original tumor are yellowish; ours were described as buff color. More distant metastases than to the mesenteric glands and the liver have been described but these are very unusual.

Clinical Course. A patient with this lesion in the small bowel may (1) live on only to die of some other disease and have the tumor discovered incidentally at necropsy, (2) die of extensive tumor growth and again have it revealed only after death, (3) have the tumor found unexpectedly when the abdomen is opened during some elective proceedure or (4) develop obstructive signs and come to operation with or without the suspicion of a tumor of the small bowel. Clinical symptoms, usually of obstruction, are present in only 17.4 to 34.8 per cent of cases according to review findings of McLeod[12] This history in these cases is usually that of chronic intestinal obstruction with

intermittent epigastric distress. Constipation or diarrhea may be present. Weight loss and weakness are often found. There is notable absence of melena and anemia which are so common in ordinary adenocarcinoma of the small bowel. An abdominal mass may sometimes be palpable.

These descriptive statements stem from the literature—generalizations from a few cases. It is conceivable that the surgeon might suspect the presence of an argentaffin tumor of the small intestine in a patient of middle age who gives symptoms suggestive of chronic partial intestinal obstruction, with no blood in the stools and with x-ray evidence of partial or complete block in the ileum. However, to expect to diagnose the carcinoid tumor preoperatively seems almost impossible.

Miller and Herman[13] describe an x-ray sign which enabled them in one instance to arrive at a correct preoperative diagnosis of carcinoid tumor. Acute buckling or kinking of the bowel is a finding in cases in which the tumor has invaded the submucosa. The authors claim that although other lesions occasionally give rise to the same phenomena, carcinoid tumor is the only small, non-ulcerated, submucosal tumor in which this sign may be elicited.

Diagnosis with the abdomen open and the lesion exposed is difficult enough and rests upon the awareness of the existence of such a tumor and suspicion that a growth in the small intestine with certain pathologic characteristics may be a carcinoid. Confirmation, of course, comes from the laboratory, either by frozen section or regular section.

The clinical course in carcinoid tumor has been both benign and malignant in the cases studied to date. But the interesting cases are the ones in which patients survive years after tumor and metastases have been identified; that a number of these exist cannot be gainsaid.

Degree of Malignancy. It is obvious from the histologic picture of immature cells (at least adolescent if not exactly young or embryonal), unorthodox structural arrangement and invasive tendencies that the carcinoid is malignant. From clinical behavior, replacement, invasion and metastasis, this tumor is also distinctly malignant. We believe it can be fairly said that the carcinoid is a malignant tumor; only a question of the degree of malignancy remains then. Some of the tumors are practically benign. Dockerty[2] has the report which best supports the tradition of semi-innocence of carcinoids. Of eleven patients operated upon at the Mayo Clinic, one died several days postoperatively (the operation being simply a biopsy) and two died after two and five years of the tumor, respectively. The remaining eight patients were living and surprisingly well ten months to nineteen years after operation. Dockerty also cites three different patients living one to twenty years after operation. He quotes Cameron[6] as saying (although not through personal experience) that 33 per cent of patients with metastasizing carcinoid live over eight years as contrasted with those having primary malignant tumors of the small bowel in which survival for ten years is less than 10 per cent. Our own patient has survived six years. It should also be pointed out that when this tumor involves the appendix, it practically never metastasizes or behaves evilly.

That the argentaffin tumor will kill is attested by the fact that Ariel[4] in a study of cases from 1930 to 1939 found fourteen cases in which it definitely caused death.

It must be emphasized that it is difficult to assemble from the literature two series of cases, one in which the carcinoid behaved as a malignant lesion and another in which it followed a benign course. The subject is young; additional case reports would seem acceptable.

Whether the degree of malignancy rests on a fine balance between host and invader can only be speculated upon; defense in one individual may surpass that in another. Carcinoma is blocked in by body opponents successfully for years in some persons. Another lack on the part of some argentaffins is the undefined toxemia which accompanies other malignant tumors, resulting in weakness and anemia. Since the mucosa over small bowel carcinoids is intact in most cases, seepage of blood into the bowel lumen does not occur and this drain on the patient's resistance is also closed.

As to the degree of malignancy, it may be said that the tumor is of very low malignancy but never of complete benignity.

Treatment and Results. When the question of treatment comes up, all speculation as to degree of malignancy or benignity becomes more or less academic; carcinoids should all be treated as completely malignant growths. Wide resection, including sufficient bowel and mesentery above and below the growth, is the pro-

cedure of choice even in the face of liver metastases. Available metastatic nodules in the liver may be removed (although not done in this case). Other procedures such as local resection of the primary lesion, side-tracking operation and enterostomies should be reserved for those cases in which complete resection for some reason is impossible; or, again, they may be employed as preliminary operations to a planned resection at a later date. These lesser operations should never be directed at cure even though reports of longevity following such procedures in patients with carcinoid tumors may falsely tempt one to do less surgery than excision. On the other hand, in a case of extensive unresectable involvement and abundant metastatic spread, the possibility that the lesion is a slow-growing argentaffin tumor should induce the surgeon to do a palliative side-tracking or other symptom-relieving procedure rather than give up, simply close the abdomen and await death. Impending obstruction might be avoided and perhaps many years of life spared.

SUMMARY

1. A case is described of carcinoid of the ileum in a white male aged fifty-five in which liver metastases were present at the time of operation. Resection and side-to-side anastomosis were done. The patient has survived eight years in good health; he is working daily.

2. The incidence of carcinoid in relation to other malignant tumors of the small bowel is one to six or 17.5 per cent.

3. Gross pathology, histopathology, invasion and metastasizing ability stamp this tumor as malignant. The tumor is known to kill. It may and often does, however, run a benign course.

4. The degree of malignancy is not constant. Many persons who have harbored this growth have survived in good health for many years, e.g., the case reported herein in which survival is now eight years with known and unremoved liver metastases.

5. Treatment should consist of radical resection of growth and underlying mesentery. The metatastatic lesions if available may also be excised.

6. The sometime benign course of this malignant lesion should never be permitted to lure a surgeon into a lesser procedure.

7. Reports on carcinoid of the small bowel are relatively few; more are needed.

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PRIMARY CARCINOMA OF THE SMALL INTESTINE*

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IN recent years there has been a constant increase in the reported cases of carcinoma of the small intestine. This can be attributed in part to the increasing interest in cancer in general and in part to the better means of diagnosing such lesions of the small bowel.

The basis of this study is a series of twelve cases of primary carcinoma of the small intestine (not including carcinoids) collected from the records of the Jewish Hospital in the last ten years. In one of these the lesion was in the duodenum, in 9 in the jejunum, and in 1 the exact site was not mentioned. Five occurred in men and seven in women. The ages of the patients in this series ranged from twenty-seven to sixty-three, averaging forty-nine years.

Symptoms. The most frequent complaint was abdominal pain or distress. It occurred in eleven of the twelve patients and was usually described as cramp-like in character. In some cases it was characterized as dull, aching or sharp. The pain was frequently referred to the epigastrium and on occasion it radiated to the back. In others the pain was localized to the mid-abdomen, lower abdomen or throughout the abdomen. The pain was related to meals in one case; in two others it was relieved by vomiting. Clinical evidence of intestinal obstruction was present in six patients. Other symptoms included flatulence, feeling of fullness, constipation and/or diarrhea, anorexia, weakness, fatigue, pallor, dyspnea and loss of weight.

Although carcinoma of the small bowel may have a long latent period during which its presence may not be detected, the average duration of symptoms as noted in this series was eight months. Six days was the shortest period and two and a half years the longest.

A palpable mass was noted in only two patients. In one the mass was firm and tender and located in the lower abdomen; in the other it was non-tender, hard and palpated in the mid-epigastrium.

Roentgenographic examinations carried out in nine cases revealed dilatation of the loops of the small intestine, stasis and fluid levels consistent with small intestinal obstruction. One study also revealed an extrinsic mass pressing upon the greater curvature of the stomach.

The tumors varied in size from 3 to 8 cm. in greatest diameter. In three instances the tumors were bulky, intraluminal and did not constrict the lumen of the bowel. In the others they were annular, hard, nodular and at times ulcerated, and constricted the lumen of the intestine. In one case the lesion had perforated and several loops of intestine were matted together. In two others the tumor was adherent to the sigmoid colon and hepatic flexure; in still another the tumor was adherent to the omentum, splenic flexure of the colon, kidney and ureter, necessitating their removal as well.

In the majority of cases carcinoma of the small intestine spreads by direct invasion of the neighboring viscera and to the regional lymph nodes. The growth is rarely disseminated to distant organs even in the terminal phase. In the present series distant metastasis was noted in one case only. In the others the spread was either local by direct extension or to the regional lymph nodes by way of the lymphatics.

Of particular interest are the histologic characteristics presented by the various tumors. The great majority of the tumors mimicked the parent tissue very closely while others showed such wide morphologic and structural variations as to bear no resemblance whatsoever to the intestinal mucosa from which they originated. Based upon their morphologic characteristics and structural pattern, these neoplasms fell into three distinct forms, namely, (1) adenocarcinoma, (2) colloid carcinoma and (3) infiltrating or undifferentiated cell carcinoma.

The striking feature of the adenocarcinoma group was the formation of gland-like structures which closely resembled the mucous glands of

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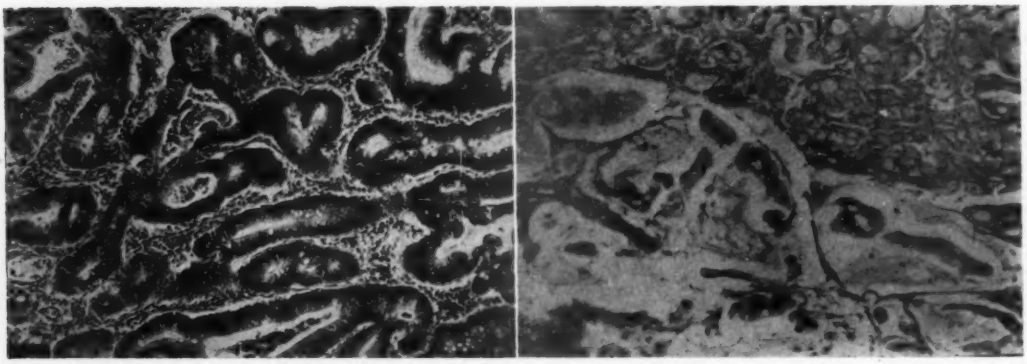

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FIG. 1. Photomicrograph of adenocarcinoma showing the typical gland-like structures.
FIG. 2. Photomicrograph of a colloid carcinoma showing the signet-ring cells and acini distended with the mucinous material.

the small intestine. The cells were tall, columnar in shape, surrounding a central lumen, and were often found to contain mucus in the cell cytoplasm itself or in the lumen of the gland. The nuclei were large, hyperchromatic and were either centrally or basally placed. Mitotic figures were encountered quite frequently denoting active growth. The stroma consisted of loose connective tissue and contained numerous inflammatory cells, particularly of the lymphocytic and polymorphonuclear variety. The latter changes were especially pronounced in the rapidly growing tumors which became ulcerated and were associated with a diffuse inflammatory process. (Fig. 1.)

The colloid carcinoma was characterized by the abundant formation of an extracellular colloid or mucoid material which greatly distended the lumina of the glandular structures compressing the tumor cells at the periphery. In other instances some of the cells were themselves distended forming the signet-ring cells in which the nuclei were somewhat crescent-shaped, eccentrically placed and deeply stained. Mitoses were infrequent. The stroma was scant and consisted of loose connective tissue infiltrated in places with round cells. (Fig. 2.)

The infiltrating or undifferentiated cell carcinoma was characterized by the presence of tall columnar epithelium sometimes polygonal, arranged in nests and strands closely packed together; it showed no tendency toward organization or definite pattern formation. Very occasionally the tumor cells were mounted on a stalk of delicate connective tissue showing a papillary-like formation. The stroma was unusually scant and consisted of scattered fibers of loose connective tissue.

COMMENT

Primary carcinoma of the small intestine is rare. During the ten-year period of this study only twelve instances of carcinoma of the small bowel were encountered. During the same period 762 patients with carcinoma of the gastrointestinal tract were admitted to the hospital. Of these, 658 had carcinoma of the large bowel. According to these figures the relative proportion of carcinoma of the small intestine to carcinoma of the remainder of the gastrointestinal tract is approximately one to sixty-four, and to the colon approximately one to fifty-five.

There is some difference of opinion as to the site of predilection for carcinoma of the small intestine. Some consider the duodenum and the peri-ampullary region as the most common sites[1–3] while others are of the opinion that they occur most frequently in the jejunum.[4] The latter observation is well borne out by our series. Still other observers place the lesion in the ileum[5] and others claim that the tumors occur with equal frequency in all segments of the small intestine.[6] Most authors agree, however, that the occurrence of the tumor is definitely more frequent in the proximal portion of the small intestine.[3,7]

The clinical picture presented by this group of cases of carcinoma of the small bowel merits some detailed description although in many respects the tumors followed the pattern previously described by many authors. The diagnosis of these tumors is sometimes beset with many difficulties. The early signs and symptoms are by themselves not distinctive and are similar to those associated with other forms of in-

testinal malignancy. The laboratory tests, although of great value, are found to be by no means infallible.

Practically all the patients presented past histories which may have had bearing on their illness. Analysis of the diagnostic facts relating to these tumors shows that pain is the most constant subjective symptom and is usually described as cramp-like in character; it occurred in practically all of the patients of the present series. Intestinal obstruction and massive bleeding are infrequent but melena is a more common finding. A careful examination of the stools for occult blood should therefore always be done whenever this lesion is suspected. An abdominal mass is rarely palpated in this disease because of the mobility of the small intestine.[2,3,7] An abdominal mass was felt in two of our patients; it was non-tender in one patient and quite tender in another.

Roentgenography was of considerable aid in the diagnosis of these tumors. The roentgenologic appearance of the lesion showed some variations in different cases. In some it presented a filling defect in the bowel wall. In others the affected bowel was constricted and appeared as a rigid tube or showed abnormal retention of barium. It may be stated that in suspected cases when the usual x-ray studies are non-contributory serial studies of the small intestine should be carried out.[7]

Anatomically, the tumors may be stenosing or polypoid and bulky in character. Ulcerations are common findings in the latter form of neoplasm. The lumen of the intestine may become partially or completely obstructed either through extensive growth of the tumor or because of its annular stenosing growth. Histologically, the tumors fall into three distinct forms, namely, the adenocarcinoma, colloid carcinoma and infiltrating or undifferentiated cell carcinoma. The adenocarcinoma is by far the most frequently encountered. The tumor rarely grows to a very large size although occasionally growth may be so extensive as to encroach on neighboring organs.

Carcinoma of the small intestine is as a rule a primary lesion and for a long time confines its growth to the intestine. As the disease progresses, the growth extends to involve the entire thickness and circumference of the bowel and even project into the lumen or form a bulge on the exterior; but its tendency is to localize in the bowel and not metastasize. In some instances, however, it tends to extend into adjoining structures, especially into regional lymph nodes. When the mucosa is also involved in the tumor process, ulceration usually follows. These changes are responsible at times for a host of symptoms. Under such circumstances bleeding may take place from the ulcerated intestinal wall and blood may appear in the stools either in the form of melena or gross hemorrhage. The latter finding is rather uncommon although occult blood is frequently found in the stools.

Diagnosis is invariably late as it is dependent on the onset of symptoms. It is well recognized that unfortunately the early symptoms of carcinoma of the small intestine are vague and apt to be confused with those of other lesions in the intestine. There is of necessity a latent period between the earliest tumor formation and the patient's awareness of something amiss; the duration of this period cannot be established at present. Owing to the low grade of malignancy of some of these growths, by the time the disease has produced symptoms of obstruction, perforation or hemorrhage it is nearing the terminal stage. Roentgen studies of these neoplasms are often helpful in locating the site of origin of these tumors and rendering diagnosis more accurate.

The ideal treatment is complete removal, if possible, with restoration of continuity of the bowel. Because of the great mobility of the small intestine it renders surgical removal of the tumor-bearing portion of the intestine a rather simple procedure. Also, due to the infrequent metastasis of the tumor to distant organs it renders complete resection of the tumor feasible, with a fairly good outlook of possible cure.

Little need be said of the prognosis in cases of carcinoma of the small intestine. If the condition is discovered early, long before metastasis has had a chance to occur, and complete resection of the lesion is done, a more favorable prognosis may be rendered. When the lesion is discovered late, permitting metastasis to take place, the prognosis as in other malignant tumors is rather poor.

SUMMARY

Twelve cases of carcinoma of the small intestine are reviewed. The most frequent site of origin of this tumor was in the jejunum.

The symptoms, pathology and treatment of these tumors are generally discussed.

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Many soldiers during World War II were cured in spite of serious cardiac wounds. Signs of anoxia, cardiac dysfunctions, friction rubs, paradoxic pulse and cardiac tamponade are some of the symptoms that should make you suspicious, when an external chest wound is present, that the heart itself may also have been injured. X-rays are of value in diagnosis providing one has sufficient time. Prompt surgery, once the diagnosis of cardiac injury has been made with reasonable certainty, is the only acceptable procedure. Through an anterior approach, transpleurally, with or without transection of the sternum, the pericardium is quickly exposed, the sac injected with a little 5 per cent novocain solution and incised to expose the cardiac wound needing repair. Oiled or waxed silk, No. 000 in size, is very suitable to suture cardiac wounds, especially when mounted on atraumatic needles. Muscle tissue from the chest wall may frequently be used to reinforce the repair and to permit better closure of the pericardiac sac. Bleeding coronary arteries may be controlled by ligatures, the insertion of metal clips or both, as needed. (*Richard A. Leonardo, M.D.*)

BILATERAL URETERAL AND RENAL AGENESIS*

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BILATERAL ureteral and renal agenesis is a comparatively rare anomaly. Amolsch in 1937 stated that bilateral absence of the kidneys is an anomaly of such rarity and interest that the finding of such warrants a report. He also stated that bilateral agenesis of the kidneys unaccompanied with some evidence of maldevelopment in other organ systems was essentially unknown. According to Hinman bilateral renal and ureteral agenesis was a developmental curiosity which occurred only in monstrosities. Grim in 1940 reported a case of an infant with bilateral renal agenesis and no other abnormalities. Soloway in 12,000 autopsies at Cook County Hospital found only two cases of bilateral anephrogenesis, an incidence of 0.0017 per cent. Potter in 1946 gave an incidence of four per one thousand deaths and stillbirths. She was the first observer to point out this anomaly as being not as rare as previously thought. She described twenty infants with findings similar to those previously reported but with only four exhibiting multiple skeletal abnormalities; in only one was the abnormality of such great disturbance as to result in sirenomelus. In her report she introduced a number of very important factors related to this anomaly which had not been previously described.

Several terms relating to abnormalities of the kidney are now well established. A brief definition of each will serve to refresh our thoughts on the subject as well as to show the relation by definition with renal agenesis. Nation's critical review with a point of establishing criteria to simplify and secure the diagnosis did much to disentangle the situation.

Renal agenesis is synonymous with *renal agenesia* and *anepbrogenesis*. This term denotes "the complete lack of development of the metanephros on one or both sides."

Renal aplasia means an incompletely or defectively developed kidney.

Renal bypoplasia or secondary atrophy "is used properly only to denote the presence of tissue of metanephric origin which has never developed any renal function, or has undergone congenital atrophy."

The embryologic development of the definitive kidney must be understood to appreciate fully the anomaly presented. During the fourth week of fetal life, at which time the fetus measures 5 mm., the ureteric bud sprouts from the dorsal surface of the Wolffian duct near the cloaca. The dorsocephalad growth of this bud seems to be a very important factor in the differentiation of the condensation of mesenchyme, the metanephric blastema. In the normal development the ureteric bud carries the nephrogenic tissue to a position at the level of the twelfth thoracic and first lumbar vertebrae. During this growth the branching ends of the bud lengthen and form the pelvis, calices and collecting tubules. Concomitant with this growth the metanephric blastema develops into Henle's loops and convoluted tubules. These tubules finally connect with the distal ends of the branching bud and receive the invaginating glomerular capillary loops to form Bowman's capsule. The Wolffian ducts in a 10-mm. embryo has already sprouted the ureteric buds and the metanephric cap has surrounded the distal portion of the ureter on its way to form the definitive kidney. Renal agenesis is believed to be due to lack of development or dorsocephalad growth of the ureteric bud. Much experimental work has been done in order to determine the true inductor of the bud. Gruenwald emphasizes the time relationship of the contact between the bud and the metanephric blastema, believing that if the contact does not take place in a limited time relationship with the metanephros the dorsocranial progress of this organ would put it out of reach of the bud.

Potter first described the two anomalies which were observed in all her cases and which she believed to be characteristically associated with renal agenesis. One was an abnormality of facial expression and the other,

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hypoplasia of the lungs. Even though these two anomalies were constantly present in all her cases, she did not believe any specific embryologic correlation existed between them and the renal anomaly. The facial characteristics pathognomonic of bilateral renal agenesis are increased space between the eyes, bilateral inner canthal folds which extend down under each eye, a flattening of the nose, marked recession of the chin, and moderate enlargement and decreased chondrification of the ears. If the aforementioned facial characteristics are remembered, the diagnosis will be made more often.

CASE REPORT

M. M., aged forty-two, was first seen in the Greenpoint Prenatal Clinic on July 15, 1948. Her last menstrual period was December 6th and the expected date of confinement September 13th. Family history was negative. The patient had pneumonia at the age of twenty-four. She began her menses at the age of fourteen; her periods were regular every twenty-eight days, lasting six days. She was a gravida IV, with three full term, normal, spontaneous deliveries. The children were well and normally developed. Serology and all urine specimens were negative. Her blood pressure was within normal limits. Her prenatal course was normal. The patient was admitted to the hospital at 4 P.M. on September 15, 1948, with mild uterine pains. Physical examination was essentially negative except for a full term intrauterine gestation, breech, unengaged; the fetal heart was regular (154); the cervix was dilated 2 cm. and membranes were intact. After a soap suds enema the pains became regular and strong. The cervix continued to dilate and at 6:00 P.M. the membranes ruptured, with the cervix dilated 6 cm. No abnormality in amount or character of the amniotic fluid was noted. At 6:30 P.M. the cervix was dilated 7 to 8 cm; the fetal heart had been slowing gradually and the rate was 80 per minute. The patient was put in the Trendelenberg position and given continuous oxygen. Despite this therapy the fetal heart continued to remain slow and slightly irregular. A diagnosis of cord compression was made. The breech was well engaged and the cervix was 8 cm. A sterile vaginal examination revealed a frank breech; a loop of non-pulsating cord was found tightly encircling the thigh. The cervix was dilated 9 cm. and the fetal heart rate was 60 per minute. Local infiltration and pudental block with ½ per cent procaine were done, followed with a right mediolateral episiotomy. The breech was brought down; the cord was released but remained pulseless. Delivery was completed with ease using Piper forceps. The child did not breathe at the time of delivery although the heart was heard faintly and irregularly, ceasing after three minutes. A normal third stage followed with the expulsion of the placenta and membranes intact. The first stage lasted three hours thirty minutes; the second, six minutes; the third, four minutes. The episiotomy was repaired in layers using interrupted chromic No. 0 suture. The patient had an uneventful postpartum course and was discharged on the seventh postpartum day.

The male child weighed, 2,500 gm. and was 46 cm. long. Externally there were no gross abnormalities of the extremities or thorax. The head presented the characteristic facies: increased space between the eyes, bilateral inner canthal folds which extended downward and laterally under each eye, a flattening of the nose, recession of the chin, and considerable enlargement of the ears (premature senility with "elephant ears"). The gastrointestinal system was normal. The thoracic cage was normal in size but a definite hypoplasia of the lungs was found. Both lungs weighed 9.5 gm.; the lung weight for a normal child of this size should be about 48 gm. Potter says that this hypoplasia of the lungs is characteristically associated with bilateral renal agenesis. The bladder was small but well formed. The prostate, seminal vesicles and testis were found to be normal. No trace of either ureter or kidney could be found. The adrenals were present; they were normal in size but somewhat rounded in shape.

One point of interest noted in this case and not obtainable in any of Potter's case histories was the intact membranes and what appeared to be a normal amount of amniotic fluid. Obviously the exact amount of fluid could not be measured but, clinically, fluid was present in what appeared to be the usual amount.

Potter's review showed that fetal death occurred after birth in approximately 50 per cent of the cases, the length of life varying from twenty-five minutes to eleven hours fifteen minutes; this child lived three minutes. In Potter's series the babies' weight varied from

700 to 3,000 gm., with a median of 1,645; this infant weighed 2,500 gm. In her series of twenty there were seventeen males and three females; this child was a male. She points out a most striking sex association with regard to the male dominance which is greater than in any other congenital anomaly except anencephaly. In the latter anomaly, with a 90 per cent incidence of females, renal agenesis has never been reported.

SUMMARY

A case of bilateral ureteral and renal agenesis is presented in a male infant at term that showed no other gross abnormalities. A review of the incidence showed that this malformation, once considered exceedingly rare, is present much more frequently.

A review of the two characteristically associated anomalies, abnormality of facies and hypoplasia of the lungs, is given.

This is the only reported case in the literature in which there were intact membranes and a normal amount of amniotic fluid. There can be little doubt, from this case, that amniotic fluid does appear in the complete absence of both kidneys.

No reports have been found which can throw any light as to the real cause of death in these infants. It does not appear that these infants die in uremia. It is hoped with this presentation and review that more cases will be diagnosed at the time of delivery and that an adequate work-up (blood chemistry and analysis of amniotic fluid) will be done so that a fuller understanding of the early neonatal as well as intrauterine physiology might be brought about.

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ARTERIOGRAPHY IN THE EVALUATION OF ARTERIOSCLEROTIC VASCULAR INSUFFICIENCY*

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THE extent of obliteration of an arterial system in an arteriosclerotic extremity generally determines the ability of the extremity to survive. The degree of arterial insufficiency has been measured by determining the patency of the arterial system by indirect methods (digital palpation, oscillometry), the condition of the skin of the extremity (temperature, color, atrophy, ulceration, gangrene) and the inability of the extremity to function normally (pain, intermittent claudication). While all of these methods yield important information, each is subject to some criticism.[6] Digital palpation, for example, may not reveal a pulsating vessel, yet the vessel may be patent and carrying blood to the tissues. Estimating the ability of the arteries to transport blood by measuring the temperature of the skin is quite an indirect method and subject to many hazards. Pain during motion or at rest has never been considered to be present invariably in extremities with arteriosclerotic ischemia.

A more accurate estimation of the degree of ischemia in these extremities would be of assistance. Desirable information includes the location or locations of the major points of obstruction and the presence or absence of functioning collaterals and their degree of development. This information as well as other important but less significant data has been shown to our satisfaction by the use of intra-arterial radiopaque material. It is the purpose of this report to summarize our experience with over 100 arteriograms in arteriosclerotic extremities. All patients have had sufficient peripheral arterial deficiency to warrant their hospitalization. In addition a classification is suggested, based upon this method of examination, which may assist in the choice and application of certain therapeutic efforts.

The use of radiopaque material† to visualize the functioning lumen of an arterial system is not new. Shortly after the discovery of the roentgen ray it was used in an amputated extremity[1] and was used in a living subject in 1923.[1] It has never become a popular method of examination because of the cumbersome and complicated procedure required for its performance.[2] The description of a simple and efficient method is contained in another report.[3]

Normal Arteriogram. For a basis of comparison the intraluminal visualization of a normal arterial tree should be understood. (Fig. 1A.) It consists of the following features: (1) There is invariably uniform filling of the femoral, deep femoral, popliteal, anterior tibial, posterior tibial and peroneal arteries. Some allowance must sometimes be made for lack of complete filling of the major vessels of the leg in the vicinity of the ankle and their extensions into the foot. If the technical details of performance[3] are carefully observed, however, good visualization is obtained even in these more distal vessels. (2) There is no irregularity or constriction of the vessel walls. (3) There is gradual uniform reduction in the size of the lumen as the vessels become more peripheral. (4) Some of the major collateral vessels are filled such as the medial femoral circumflex, the highest genicular and occasionally other anastomotic genicular vessels. In general, however, there is a minimum of filling of the collateral branches. Collateral branches, like secondary highways, are only put to heavy use when the main stream of traffic is obstructed.

ARTERIOGRAPHIC CLASSIFICATION OF ARTERIOSCLEROTIC EXTREMITIES

All arteriosclerotic extremities will exhibit certain arteriographic features such as irregularity and roughening of the vessel walls, constriction of the lumen at various points and a tendency toward development of collateral circulation. Any classification of these extremities

† Although various agents may be suitable for this examination, diodrast (Winthrop-Stearns) has been used exclusively in this study.[3]

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must be a division in respect to degree of obstruction of the main vascular channels.

No Occlusion of Major Vessels. The first classification represents an arteriosclerotic extremity with obstruction due only to narrowing of the lumen. Major vessels mentioned in the normal arteriogram are filled. There is irregularity and constriction of the major vessels and an increase in collateral filling. (Fig. 1B.) The significant feature is the absence of any complete occlusion of a major vessel. The majority of patients in this classification are elderly people without clinical features sufficient to require hospitalization. For this reason the number of patients examined in this group was small compared to that of other groups.

One of Two Patent Major Vessels of the Lower Leg. The second classification demonstrates complete filling of the major vessels of the thigh but complete occlusion of one or two of the three major vessels below the popliteal artery. (Fig. 1C.) Collateral filling may be considerably increased, especially below the knee. Clinically, there seems to be little difference whether the anterior or posterior tibial vessels are occluded. In only two cases have both of these arteries been found to be occluded and the peroneal artery patent. In the majority of cases, however, occlusion occurs at the bifurcation of the popliteal artery.

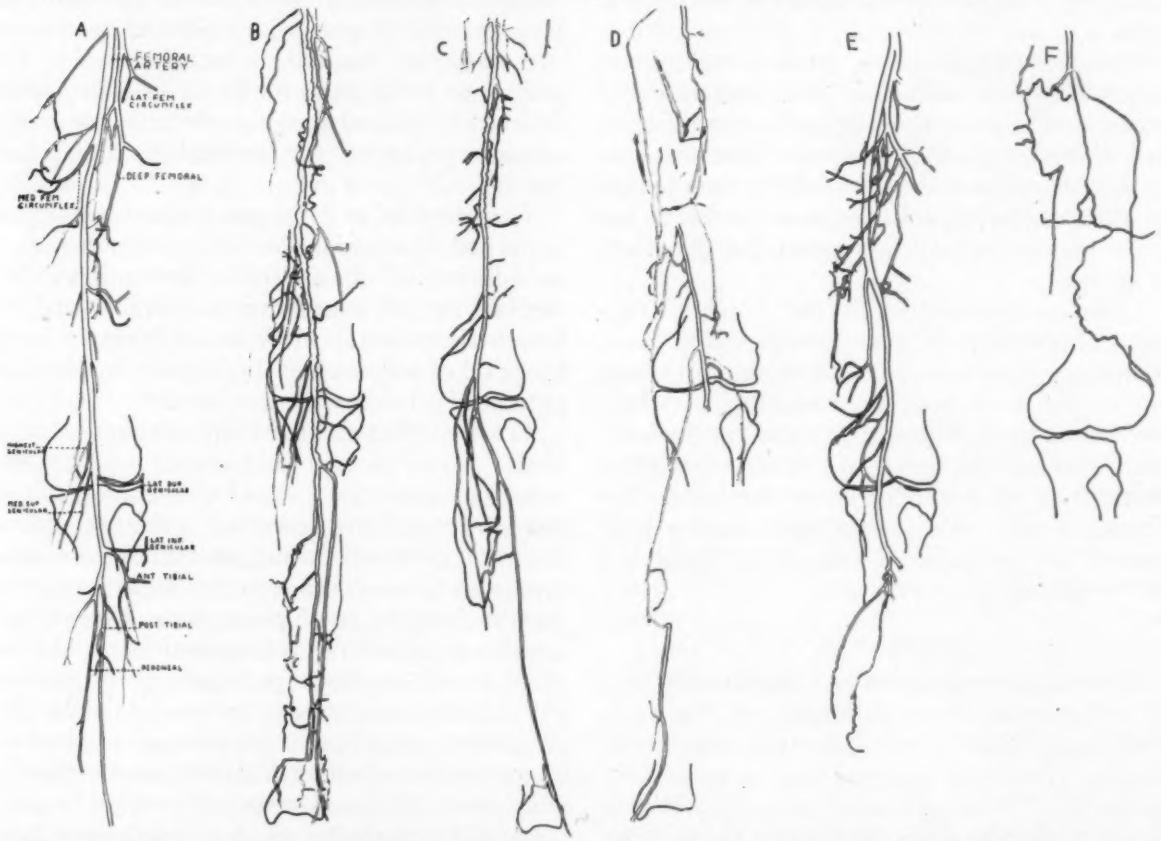

FIG. 1. Tracings made from arteriograms. A, normal arteriogram; B, occlusion showing irregularity of vessels and increased collateral development but no complete occlusion in any major vessel; C, occlusion showing patent anterior tibial artery; D, segmental occlusion. Two segmental occlusions appear in this tracing. The highest occlusion occurs high in the femoral artery and the vessel refills at the mid-femoral region. The popliteal artery is occluded at its bifurcation and by means of the highest genicular artery the posterior tibial is filled in its lower one-half. E, Complete occlusion at the popliteal level; F, complete occlusion in femoral artery.

Segmental Occlusion. The third classification includes complete occlusion of a segmental type. (Fig. 1D.) "Segmental occlusion" implies a patent collateral system of a degree sufficient to fill a major vessel below the point of obstruction. This may occur at any site in the arterial tree but in our experience most often occurs in the femoral or popliteal arteries. The significance of this type of obstruction, of course, lies in the difference in amount and pressure with which the arterial blood is delivered to the tissues. Anatomically, the extremity may resem-

ble the second classification in which at least one major vessel is capable of delivering blood to the leg and foot. Physiologically, however, the extremity may resemble the more advanced groupings for blood, under decreased pressure and in less sufficient amount, is less capable of adequately supplying the tissues of the leg and foot.

Complete Obstruction below the Popliteal Artery. Complete occlusion of the anterior and posterior tibial and the peroneal arteries results in inability of the foot to survive unless the occlusion develops over a sufficiently long period to allow the small collaterals of the leg to assume the entire task of nourishing the foot. (Fig. 1E.)

Complete Obstruction in the Thigh. Complete obstruction of the femoral artery most frequently occurs at the bifurcation of the deep and superficial femoral arteries. (Fig. 1F.) It is the lesion most frequently found in patients with gangrene of the entire foot and various portions of the lower leg below the knee. Collaterals alone, unless developed over a long period, are incapable of adequately supplying the whole leg.

COMMENTS

Visualization of the lumen of an arterial tree in an arteriosclerotic extremity is the only method available by which the type, extent and location of arterial occlusion may be accurately measured. The technic previously described[3] is simple enough to allow its routine use in large clinics. Arteriosclerosis has been listed by some as a contraindication to arteriographic examination. Blakemore[4] suggests that radiopaque material may sufficiently irritate the intima as to initiate or propagate thrombi in borderline cases. With this in mind we have subjected fifty patients with gangrenous digits and feet requiring a major amputation to arteriographic examination. Examinations were made at various intervals prior to amputation, ranging from a few hours to three weeks; the arterial systems of the amputated extremities have been carefully studied. In no case have we discovered evidence to suggest that initiation or a hastening of the occlusive process could be attributed to this procedure.

Some authors[4] consider the occurrence of vasospasm following the procedure sufficiently important to contraindicate its use in these patients. Robb and Steinberg[5] have shown that the pharmacologic action of diodrast is that of a vasodilator. Clinically, nearly all patients subjected to this procedure show evidence of vasodilatation and some with ischemic pain are temporarily relieved. Vasospasm may occur, however, as a result of the trauma of an arterial puncture. In our series we have had one patient exhibiting definite signs and symptoms of vasospasm. Such an occurrence can be expected to be of little importance if promptly relieved by a lumbar sympathetic block or the administration of the tetraethyl ammonium ion.

The practical advantages of arteriography as a method of examination fall into three groups as follows: (1) It assists in determining the desirability of conservative therapy and/or local amputation. (2) It is an aid in determining the level of amputation. (3) It aids in selecting patients for lumbar sympathectomy.

There would seem to be little argument with conservative therapy in patients whose local ischemia has not progressed to the point of tissue death (patients described in the first classification). Although in some instances the symptoms may be severe enough to warrant amputation in the absence of gangrenous changes, the usually accepted medical measures should be given a trial, combined perhaps with surgical or chemical autonomic denervation. Logically, the visual demonstration of the presence or absence of competent vessels will indicate more clearly whether or not the process will proceed to gangrene and amputation. Such information will be of great assistance in determining the course of therapy.

Local amputation, in itself a conservative measure, should be used only in carefully selected cases.[7,8] It has been pointed out that such insufficient measures as digital amputation in an inevitably progressive process hasten the gangrenous process through local trauma, require multiple procedures in poor risk patients when one would suffice, initiate or add to the factors of infection and add to the total mortality of supracondylar amputation. Such observations are entirely correct in patients in whom the main vascular channels are obstructed and whose collaterals are underdeveloped to the point that necrosis at the distal portions of the extremity slowly but invariably progresses. If patent major vessels and well developed functioning collaterals can be demonstrated, these disadvantages probably do not apply.

The correlation between clinical features and the arteriographic findings has not proceeded to the point at which we can always estimate the viability of the tissues. In the beginning we arbitrarily assumed that all patients in the first and second classifications (in whom at least one functioning lower leg vessel was present) were entitled to conservative therapy if not otherwise contraindicated. In these two groups we subjected to digital amputation eight patients whose gangrene was limited to the digits; five ultimately required reamputation below the knee. In view of this high reamputation rate we are now advising local amputation only for patients in the first group. However, we still carry out digital amputation on many patients who are unwilling to accept a major amputation even though we are aware that a more major procedure will ultimately be required.

Arteriography is helpful as an aid in determining the level of amputation. It often suggests patients in whom a lower leg amputation will most likely be successful but more conclusively determines which ones will result in failure. A broad relationship exists but we have been unable to demonstrate any close correlation between obstruction at various levels and the site or extent of gangrene, particularly in the digits. Conversely, from the location of the gangrenous portion we have been unable to predict accurately the site of obstruction or degree of collateral development. It seems obvious, however, that those extremities exhibiting obstruction as described in the third, fourth and fifth classifications with little or no collateral development, even though the gangrenous process is limited to one or two digits, would tolerate the trauma of lower leg amputation poorly and result in a high percentage of reamputations. This has been borne out in a few cases in which lower leg amputation was done despite arteriographic evidence of a complete block in the femoral artery. In ten other lower leg amputations, all exhibiting obstruction as in the second classification or less, none had wound infection or necrosis of the stump sufficient to require reamputation.

Although our follow-up data on postsympathectomized patients are too incomplete for definite conclusions, arteriography has appeared to be helpful in selecting patients for lumbar sympathectomy. Since the rationale of this operation is the release of vasomotor tonus of the smaller arteries and arterioles, the presence of an adequate network of collaterals in the presence of major obstruction is necessary if a good result is to be achieved.

Arteriography is important for use in a large peripheral vascular clinic. It is an excellent method of teaching the fundamentals of arteriosclerotic occlusive disease in that it is a visual method that depicts the patency of the major vascular channels. The information gained by the inexperienced or the occasional examiner probably does not justify its routine use.

SUMMARY

1. Arteriography in arteriosclerotic disease of the lower extremities is a safe and easily performed examination.

2. It is of assistance in determining patients unsuitable for local amputation and/or other conservative measures and in selecting patients for lower leg amputation.

3. It may be of assistance in determining more suitable candidates for sympathetic denervation.

4. Its use in large vascular clinics is warranted but the information gained in occasional examinations probably does not justify its routine use.

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EFFECT OF REMOVING THE ADVENTITIA BEFORE ARTERIAL SUTURE ANASTOMOSIS*

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STRIPPING or excising the adventitia from the ends of a divided artery before performing end-to-end suture anastomoses has long been established as a procedure to prevent thrombosis. Guthrie,[1] Horsley,[2] Markowitz,[3] Herman[4] and Shumaker[5] are a small number of the writers who have included it in their technic. The adventitia is very rich in thromboplastic material and in addition has the physical property of being sticky, forming material to which platelets may adhere.[3] Therefore, most writers have thought that if not removed, strands of adventitia would be carried into the lumen of the artery by the anatomosing suture and there act as a nidus of thrombus formation.

However, the nutrient blood vessels of the artery or vasa vasorum run in the adventitia and we thought that removing the adventitia might destroy the blood supply of the media and increase the incidence of secondary hemorrhage. Credence is given to this idea by the following description of the vasa vasorum by Bailey:[6]

"Arteries and veins with a diameter over 1 millimeter are supplied with small nutrient blood vessels, the vasa vasorum. These vessels enter and branch in the adventitia and terminate in a capillary network which penetrates the media, probably reaching its deepest layers. No capillaries are found in the intima."

It was decided to test this hypothesis in anesthetized adult mongrel dogs by dividing the common carotid artery and performing end-to-end suture anastomoses. The common carotid artery was chosen because of its size and accessibility. There were three series of animals in the experiment. In the first series the adventitia was stripped before anastomosis, in the second the adventitia was retracted gently but was not stripped. In order to have more complete control over individual variations in the animals, a third series of anastomoses was performed. In this series both carotids of each animal were divided and anastomosed during one operation, the adventitia being stripped on one side and gently retracted on the other.

Materials and Methods. To facilitate end-to-end suture anastomosis of the common carotid artery we have devised a clamp which can be readily applied to any of the accessible large arteries. This clamp allows the ends of a divided artery to be approximated and sutured in the completely relaxed state and is easily removed, allowing reestablishment of blood flow without any undue tension on any one part of the suture line. In addition, it eliminates having an assistant hold stay sutures and makes it possible for the operator to perform the anastomosis alone—a great advantage in experimental surgery.

The clamp (Fig. 1A) assembled consists of three parts, namely, two specially ground rubber-covered hemostats (Fig. 1B) and a holding bar. (Fig. 1C.) The bar has a fixed set screw at one end and a slot in which a movable set screw is attached. The hemostats fit in the set screws. This movable set screw is attached. The hemostats fit in the set screws. This movable set screw can slide along the slot in the bar and has a wing nut which is capable of locking it at any position on the bar. The hemostatic clamps (Fig. 1B) were made by grinding down the blades of ordinary hemostats. The inner surfaces were made concave and the blades thinned until they were flexible. These were then covered with thin rubber tubing so that they could be closed over the vessel without injuring its wall.

To use the clamp one of the rubber shod hemostats is placed on the lower end of the previously exposed arterial segment about an inch from the mid-portion (proximal to the heart). The other hemostat is placed in a similar position on the upper end of the seg-

* From the Department of Surgery, Doctor's Hospital, Washington, D. C. This investigation was supported by a grant from the Office of Naval Research, United States Navy.

ment (distal to the heart). (Fig. 2A.) The artery is divided mid-way between the two rubber shod hemostats with sharp scissors and the ends irrigated free of blood with normal saline. The hemostatic clamps are then fixed in the holding bar set screws. The movable set screw is adjusted so that the cut ends of the artery will be approximated. The two parts of the holding bar are then pushed together and the wing nut on the movable piece is locked. The cut ends of the vessel are thus approximated and sutures may be placed without any tension on the suture line. (Fig. 2B.) Three stay sutures are inserted and tied to triangulate the circumference of the two segments in the following manner: One stay suture is placed in the middle of the anterior surface of the approximated segments. The clamps are then turned over or rotated away from the operator so that the posterior surface becomes anterior (however, it will continue to be referred to as the posterior surface). (Fig. 2C.) A second stay suture is inserted in the now lateral part of the posterior or edge of the posterior surface nearest the operator. The third stay suture is inserted on the now medial or edge of the posterior surface distal to the operator. The end of the third stay suture is left long and the needle is not cut off. This is used to insert the hemostatic suture line. All the sewing is done towards the operator. In the three series of experiments the anastomos-

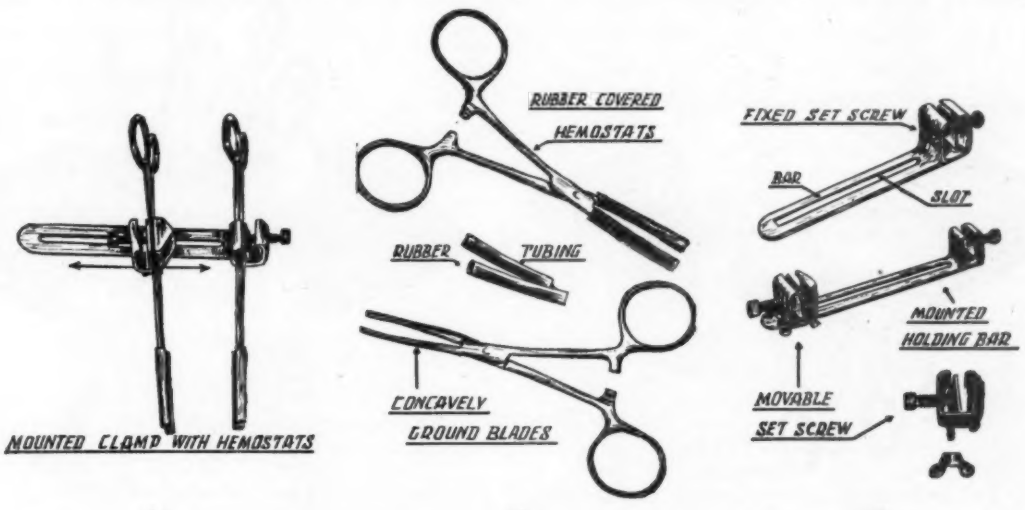


FIG. 1. A, the assembled clamp showing hemostats fixed in set screws and the slot in which the movable set screw can be adjusted; B, specially made rubber-covered clamps; C, parts of the clamp unassembled.

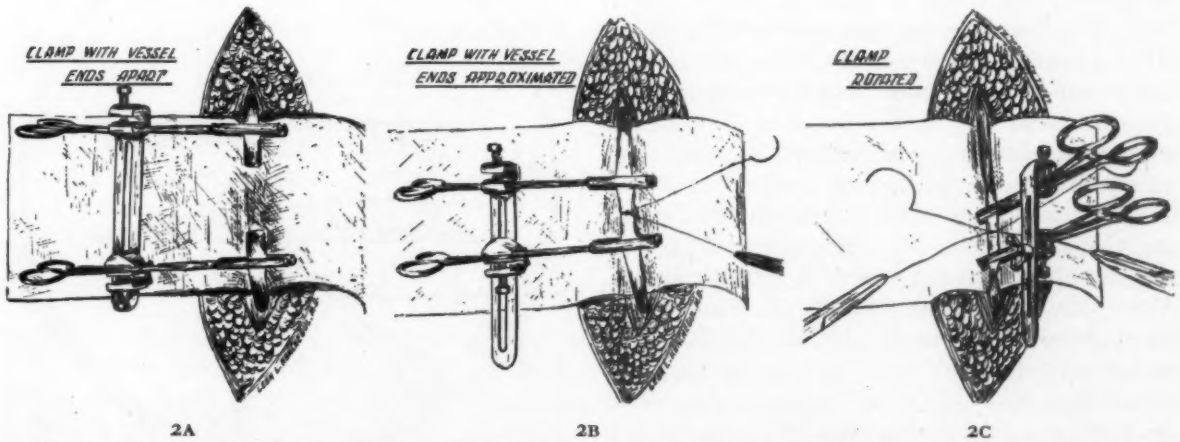


FIG. 2. A, clamp, applied, showing hemostatic clamps on vessel; B, clamp adjusted to approximate cut ends of vessel without tension on suture line; application of anterior stay suture; C, rotation of clamp bringing posterior surface into view; application of posterior sutures.

ing suture was inserted in the form of a running lock or blanket stitch.[8] Braided silk (5-0) on a No. 9 atraumatic needle was used throughout.* The advantages of braided silk over twisted silk have not been emphasized enough in the literature in our opinion. As each stay suture is passed, the hemostatic suture line is tied to it, thus preventing a purse-string effect. After passing the second stay suture the clamps are rotated 180 degrees back to their original position near the operator. The hemostatic suture line is continued, tied to the first stay suture and finally to its own end.

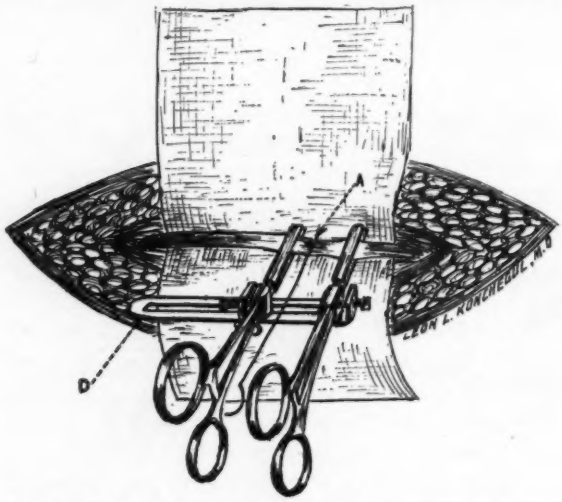
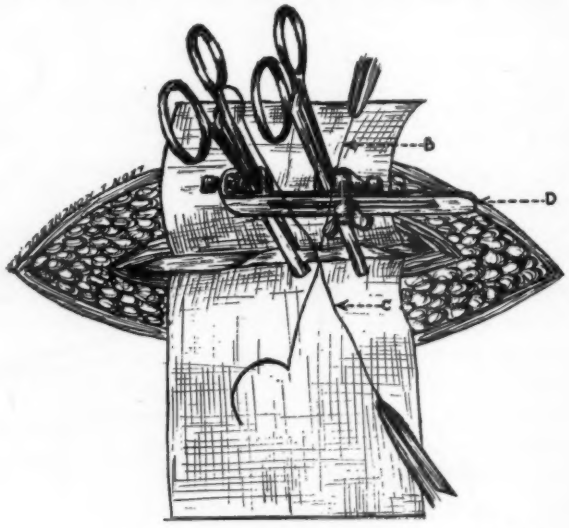


FIG. 3. The ends of the divided artery are approximated by the specially devised holding clamp (D); the first stay suture is inserted at (A).

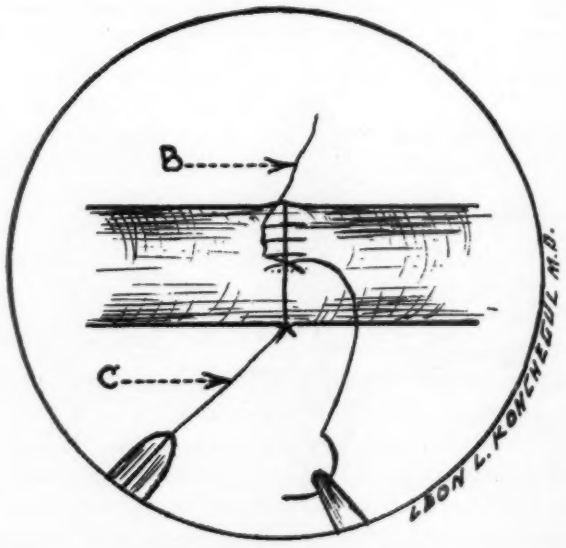
The holding bar is then removed by loosening the set screws. The hemostatic clamp on the distal end of the artery is then released. This allows the artery to fill up from below through its collateral circulation. Any bleeding points may be dealt with by placing an additional suture at this time. Oozing is controlled by placing a moist compression sponge on the bleeding area for a few minutes. When all bleeding has ceased, the upper hemostatic clamp is removed, allowing circulation to be reestablished. (Figs. 3, 4A and 4B.)

The technic described before was used in the three series of anastomoses. The only technical variation was the method of handling the adventitia. If stripped it was pulled off the media for ¼ inch from each of the divided ends and excised. The method of stripping was much more extensive than would normally be used in arterial surgery. If retracted none was excised and care was taken to see that it was not torn from the media at each of the divided ends before performing the anastomosis.

The animals were killed under nembutal®



4A



4B

FIG. 4. A, the holding clamp (D) has been rotated away from the operator to expose the posterior circumferences of the ends of the divided artery. The second stay suture has been inserted in the edge nearest the operator at (C). The artist has drawn the needle much too large. The end held by the hemostat is left long for traction and the suture with the needle attached is cut close to the knot. This is shown at (C) in Figure 4B. The third stay suture is inserted distal to the operator at (B). The end of the third stay suture is left long and the needle is not cut off. It is used to insert the hemostatic suture line, and is shown at (B) in Fig. 4B, details of inserting the running lock stitch are shown here and also in Orr's book.[8]

* Deknatel supplied by J. A. Deknatel & Son, Inc., Queens Village, N. Y.

anesthesia at intervals of two weeks to nine months. A suture anastomosis functioning fourteen days or longer was termed successful. Results were evaluated by gross and microscopic examination.

OBSERVATIONS

Stripping of Adventitia. In the first series the adventitia was stripped before suture anastomosis of fifteen common carotid arteries.

TABLE I

Dog No.	Weight (Lb.)	No. of Previous Operations	Carotid Artery Used	Fate
1	30	2	Left	Patent 5 wk. later
2	23	0	Right	Patent 2 wk. later
		2	Left	Patent 2 wk. later
3	18	0	Left	Patent 2 wk. later
4	24	1	Left	Patent 5 wk. later
		2	Right	Patent 6 wk. later
5	30	0	Right	Thrombosed 2 wk. later
		1	Left	Patent 2 wk. later
6	35	0	Right	Patent 2 wk. later
		1	Left	Hemorrhage, death, 3 da. later
7	21	0	Left	Partial thrombosis 12 wk. later
8	35	0	Left	Patent 12 wk. later
		1	Right	Thrombosed 12 wk. later
9	23	0	Right	Hemorrhage 8 da. later
		1	Left	Patent 36 wk. later

The results were as follows: Sixty-six per cent (ten) of the arteries were patent, 20 per cent (three) were thrombosed and necrosis occurred at the site of anatomosis causing severe hemorrhage in 14 per cent (two). (Table I.) The number of operations that had been performed upon each animal previous to the suturing of each carotid artery is tabulated because of possible effect on incidence of thrombosis. No effect is apparent.

Adventitia Retracted, Not Stripped. In the second series suture anastomosis without stripping the adventitia was carried out on sixteen carotid arteries in eight dogs. Both carotids of the animal were divided and anastomosed at one operation. The adventitia was retracted but was not stripped or excised from the cut ends of the artery. Gross examination of the anastomosis was carried out at the end of two weeks or a greater period of time. Seventy-five per cent (twelve) were patent, 25 per cent (four) were thrombosed and there were no cases of secondary hemorrhage. Table II. It may be noted that thrombosis when it occurred tended to occur on both sides.

At this time it was believed that the difference between the incidence of hemorrhage and thrombosis in the first and second might be significant.

TABLE II

Dog No.	Weight (Lb.)	Left Carotid	Right Carotid
1	24	Patent 8 wk. later	Patent 8 wk. later
2	23	Patent 7 wk. later	Patent 7 wk. later
3	12	Patent 16 wk. later	Patent 16 wk. later
4	14	Thrombosed 12 wk. later	Thrombosed 12 wk. later
5	25	Patent 15 wk. later	Patent 15 wk. later
6	26	Thrombosed 8 wk. later	Thrombosed 8 wk. later
7	16	Thrombosed 2 wk. later	Thrombosed 2 wk. later
8	20	Patent 4 wk. later	Patent 4 wk. later

However, in any comparison of this kind the effect of improvement of the operator's skill must be taken into consideration, and in addition, there may be individual variations in different animals. Therefore, it was decided to test the effect of removing the adventitia in a larger series in which suture anastomosis of both carotids of the animal were carried out at one operation, the adventitia being stripped and excised on one side and retracted on the other.

Adventitia Stripped and Excised on the Left, Retracted on the Right. In order to facilitate keeping records in the third series the adventitia on the left was stripped back for ¼ inch from the ends of the divided artery and not stripped on the right. In the previous thirty-one arteries there had been no appreciable difference in the degree and nature of healing or predisposition towards thrombosis in the two. This series consisted of twenty animals. The technic was carried out as described previously. There was little deviation and no significant difference in results on the two sides. In the anastomosis with the adventitia stripped and

removed, 65 per cent (thirteen) were patent, 30 per cent (six) were thrombosed and 5 per cent (one) hemorrhaged.

In the anastomosis with the adventitia not stripped but retracted, 60 per cent (twelve) were patent, 30 per cent (six) were thrombosed, 5 per cent (one) both hemorrhage and thrombosis were present. In the last one it was not possible to tell which occurred first. (Table III.) In the animals with hemorrhage it had been noted that the sutures were placed closer together than 1 mm. In the other animals an interval of 1 mm. to 1½ mm. was maintained. It is logical that close suturing, especially with the running lock type of stitch, will cause necrosis of the arterial wall.

TABLE III

Dog No.	Weight (lb.)	Left Carotid	Right Carotid
1	15	Patent 4 wk. later	Patent 4 wk. later
2	15	Thrombosed 6 wk. later	Thrombosed 6 wk. later
3	25	Hemorrhage 48 hr. after operation	Thrombosed with a small area of hemorrhage walled off
4	50	Patent 3 wk. later	Patent 3 wk. later
5	35	Patent 2 wk. later	Patent 2 wk. later
6	50	Patent 2 wk. later	Patent 2 wk. later
7	55	Patent 3 wk. later	Patent 3 wk. later
8	55	Patent 3 wk. later	Patent 3 wk. later
9	39	Patent 2 da. later	Hemorrhage 2 da. later
10	35	Thrombosed 4 wk. later	Thrombosed 4 wk. later
11	36	Patent 2 wk. later	Patent 2 wk. later
12	20	Thrombosed 3 wk. later	Thrombosed 3 wk. later
13	35	Patent 11 wk. later	Patent 11 wk. later
14	37	Patent 10 wk. later	Patent 10 wk. later
15	35	Thrombosed 6 wk. later	Thrombosed 6 wk. later
16	45	Patent 3 wk. later	Patent 3 wk. later
17	17	Thrombosed 2 wk. later	Thrombosed 2 wk. later
18	34	Patent 12 wk. later	Patent 12 wk. later
19	35	Thrombosed 11 wk. later	Thrombosed 11 wk. later
20	22	Patent 3 wk. later	Patent 3 wk. later

COMMENT

The results of the third series give evidence of a constitutional factor causing thrombosis. Thrombosis, when it occurred, tended to occur on both sides without regard to technic.

Two explanations may be postulated, namely, (1) the circulating blood of certain individuals may contain excessive amounts of a factor causing thrombosis. Recent work of Shadid[7] indicates this can be measured by blood viscosity. (2) The arteries of certain individuals may be more sensitive to trauma. In sensitive individuals the spasm resulting from routine manipulation of the artery decreases the size of its lumen, forming a constricted segment with stagnation of flow and consequent predisposition towards thrombosis.

Eight pairs of the patent arteries were examined microscopically at George Washington University Hospital. The opinion was unanimous that the degree and nature of healing was the same in both types.

The results obtained may apply only to the anastomoses of muscular arteries. An elastic artery, aorta or innominate, may be more sensitive to the stripping of the adventitia.

SUMMARY

1. A new clamp for end-to-end anastomosis of peripheral blood vessels is described.

2. Removal of adventitia before suture anastomosis of the common carotid artery in anesthetized mongrel dogs has little or no effect on the incidence of thrombosis and hemorrhage and does not interfere with the degree and nature of healing of the anastomosis.*

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*We are grateful to Dr. J. Ross Veal for valuable suggestions throughout this work.

NEW METHOD OF INTRA-ARTICULAR ARTHRODESIS BY TRANSPOSITION OF LOCAL CANCELLOUS BONE*

A PRELIMINARY REPORT

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THE principle of this new method of arthrodesis is the intra-articular transposition of a local cancellous bone graft by an extra-articular approach. The graft goes through the articular surfaces and immobilizes the joint.

It is known that the cancellous bone graft has the best biologic qualities. The graft usually employed is taken from the iliac crest; that part of the iliac bone, however, has little resistance against mechanical strain. It is difficult to take thick cancellous bone grafts from the iliac bone. This type of graft is better suited to fill bone cavities or stimulate osteogenesis but has poor mechanical qualities to immobilize the joint.

We may consider the epiphysis of the long bones as a block of cancellous bone covered by a thin layer of cortical bone and cartilage. Nevertheless, it offers great resistance to mechanical strain. The resistance of cancellous bone is given by its lamellas that are turned in the direction of strain lines according to functional necessities (Wolff's law). The head and the neck of the femur, for instance, offer great resistance to trauma by the position of their lamellas in strain lines. This is the reason why fractures are exceptional at that level in young people. The cancellous part of long bones, therefore, presents great resistance besides good osteogenic properties that are common to cancellous bone in general.

Based on these considerations we decided to employ local cancellous bone in an arthrodesis. Our first patient was operated upon in September, 1945. The patient had a bent right shoulder as a sequela to poliomyelitis. Subluxation of the shoulder was also present. The muscles of the forearm and hand were active. The case was a good one in which to test the efficiency of the method because in addition to the poor blood supply of the paralyzed limb there were also local unfavorable mechanical conditions, namely, gravity and muscle paralysis which caused separation of the articular surfaces. In this patient a solid arthrodesis was obtained in a short time.

The good results of this case led us to try the same technic in the hips of three patients. The result was sound fusion of the joint in all cases. The hip joint is the best site for this kind of arthrodesis; the articular surfaces stay in close contact and do not spread apart as in the shoulder. On the other hand, cancellous bone of the neck of the femur is accustomed to heavy mechanical strain. With the strain of weight-bearing the graft is modelled to its new function; therefore, a sound arthrodesis can be obtained. We performed the same operation with good results upon another patient with paralysis of the shoulder due to severe neuritis of the axillary nerve.

INSTRUMENTS

Four instruments are required which we have designated as A, B, C and D. Part A, the main part of the set, is a tubular saw. It is a hollow cylinder 18 cm. long and 22.5 mm. in diameter; its inner surface is regular and is 21 mm. in diameter. The thickness of the wall is 0.15 mm. End a′ is a saw with twenty-four teeth. End a″ is threaded with a slight circular depression; this end is attached to the threaded end of part D. The inner wall is marked every 5 mm.

Part B is a hollow cylinder the same size as part A and is also marked every 5 mm. End b′ is a bur with four teeth connected to the cylinder by a neck *b″*. The diameter of the bur is smaller, having exactly the inner diameter of part A, namely, 21 mm. End b″ of part B is threaded with the same characteristics of part A.

Part C is a solid piston with similar marks to those of parts A and B. End c′ is 20.9 mm. in diameter, slightly smaller than the inner diameter of part A. End c″ has a larger diameter than the inner diameter of part A.

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Part D is a solid handle with one end threaded; this threaded end fits similar threads of parts A and B. This screw is to avoid too much tightening of the threads when the instruments are in use.

joint are only different in their approach. The incision must be made so that the handling of the instruments will be simplified; its direction should be perpendicular to the articular surfaces.

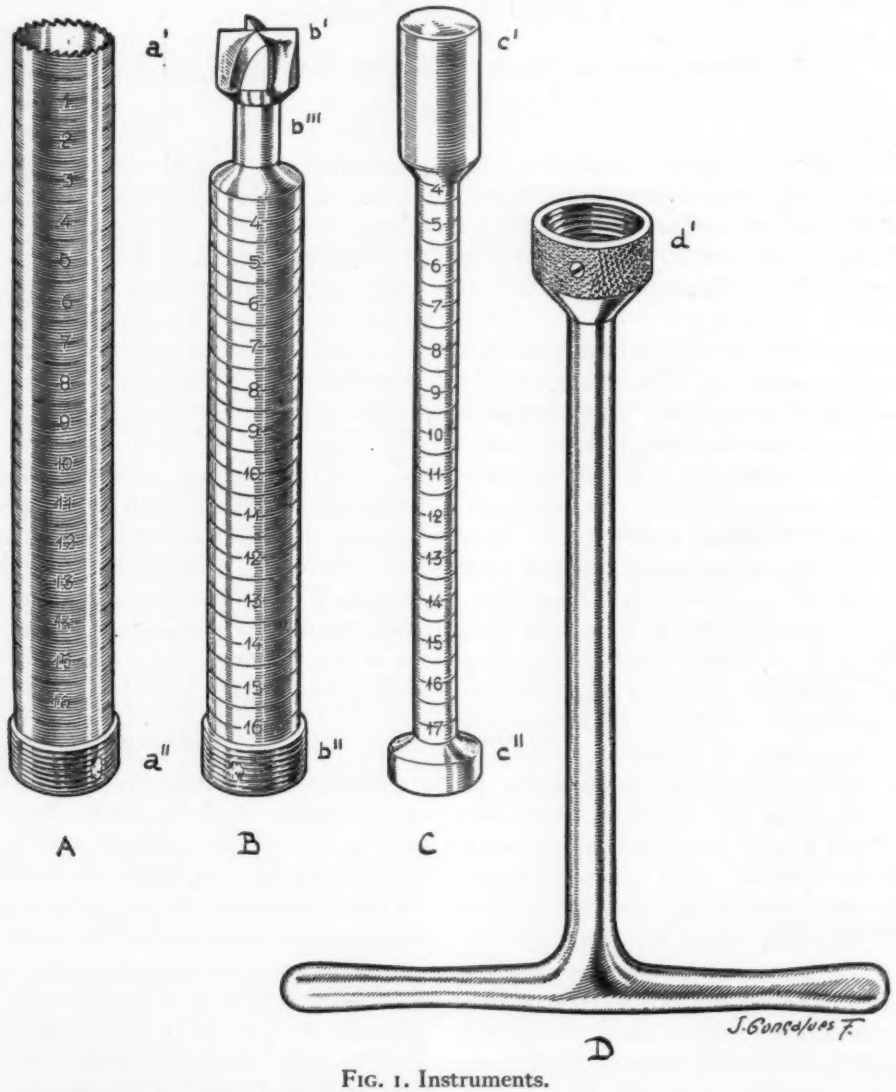


FIG. 1. Instruments.

Part A is used to take the grafts and at the same time to prepare the bed for them. Part B, used more frequently in operations upon the hip, takes the graft from the acetabulum when it is not possible to remove it with part A. Part C removes grafts from part A and pushes them into their beds. Part D moves parts A and B manually. (Fig. 1.)

TECHNIC

We have chosen arthrodesis of the hip to show the technic. Arthrodeses of other joints such as the shoulder, knee and subastragaloid

The patient lies on the orthopedic table with the joint to be arthrodesed in the ideal functional position. Contractures and stiffness that may be present must be corrected. Two x-ray apparatus must be available, or at least one, to check the different surgical stages. The use of guide or Kirschner wires is unnecessary; they make the technic only more difficult.

The skin incision is the same as that used in the screwing of the neck of the femur by the extra-articular approach, namely, about 8 cm. long on the trochanteric region. The fascia lata and vastus externus muscles are exposed to

their upper insertions at the bottom of the great trochanter. The vastus externus muscle is divided vertically and the division is completed with an L-shaped incision at the level of the muscle's upper insertion. By means of a rougeur the lateral aspect of the femoral shaft is exposed. (Fig. 2.)

With chisel and mallet we make a groove in the cortex of the lateral aspect of the femur (Fig. 3) about 1 inch below the upper insertion of the vastus externus muscle. The drilling with part A is made easier because of this groove. With part A fitted to part D, 2 cm. of the tubular saw are introduced into the cortex with rotatory movements. (Fig. 4.) At that time we take two check x-rays, anteroposterior and lateral, and watch the position of the cylindrical saw with regard to the neck of the femur and acetabulum. The dotted line shows the direction that the saw must take. If the direction is not satisfactory, the saw is withdrawn and the drilling started a second time.

When the direction of the saw in relation to the neck of the femur is correct in both views as per check x-rays, we introduce the saw up to the acetabulum with rotatory movements. This penetration is controlled by the marks of part A. Another anteroposterior x-ray plate is made to check on the penetration of the saw into the wall of the acetabulum; there is no danger in slight overpenetration. (Fig. 5.)

The tubular saw is then withdrawn also by rotatory movements. It brings out the cancellous bone graft from both the neck of the femur and the wall of the acetabulum. When the graft from the acetabulum does not come out we utilize part B which has been attached to part D. Its position is the same as that prepared by part A. By means of rotatory movements the bur enters the acetabulum. The penetration of the bur is controlled by the markings, the same as that reached by part A. Part B is then withdrawn and the bed is ready to receive the graft. The diameter of the graft taken from the acetabulum is the same as that obtained from the neck of the femur because the bur of part B has the same inner diameter as part A. (Fig. 6.)

Part D is then attached to part C and the grafts are pushed out with taps by a mallet, cartilaginous parts of the grafts are excised and the graft is ready to be imbedded. (Fig. 7.)

The graft from the neck of the femur is placed in its bed and with the aid of part C the graft is pushed to the bottom of the bed in the acetabulum with slight taps of the mallet. The marks in part C minus the length of the graft determine the degree of penetration. (Fig. 8.) When the graft from the acetabulum is withdrawn in one block, it is used to form the bed. (Fig. 9.)

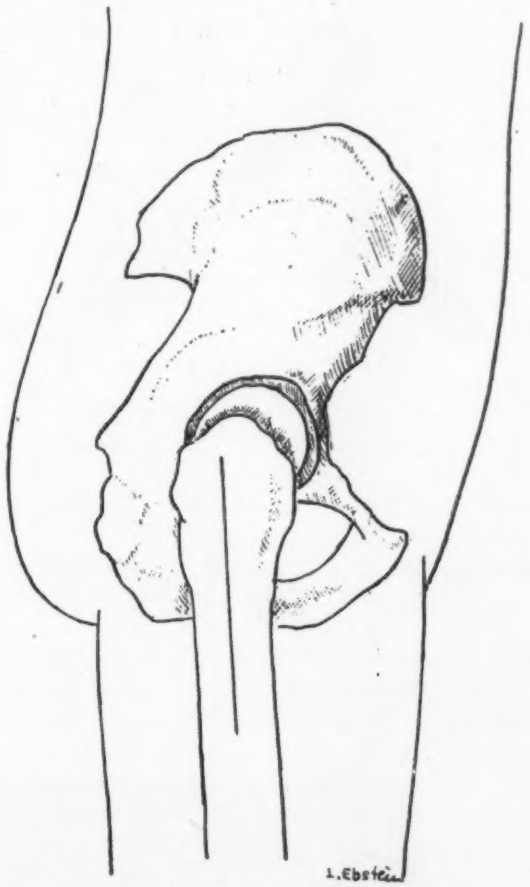
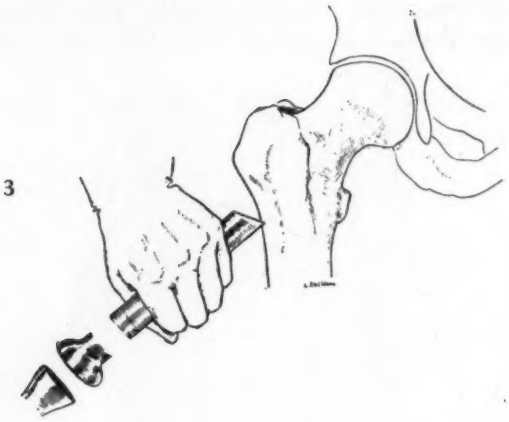


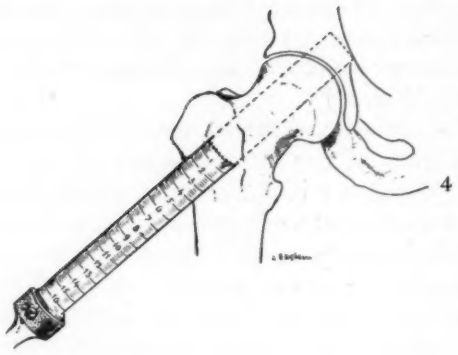
FIG. 2. Incision for exposition of the femoral shaft.

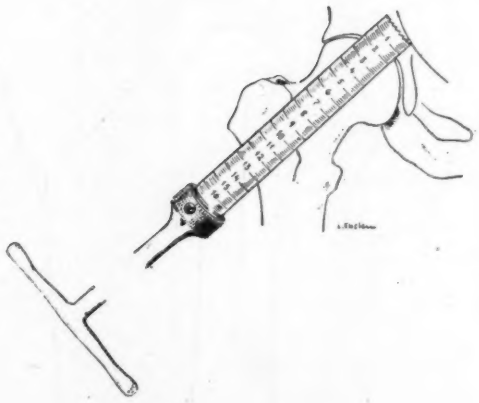
The suturing of soft tissues is done by layers according to the usual technic.

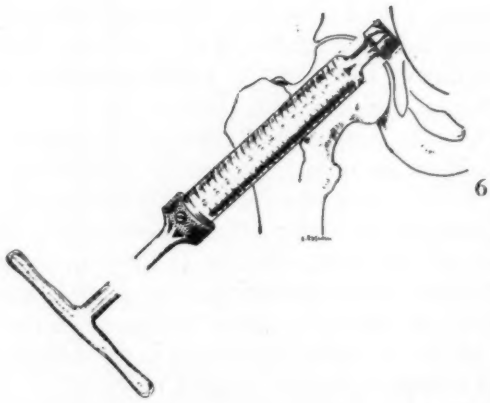
ADVANTAGES OF TECHNIC

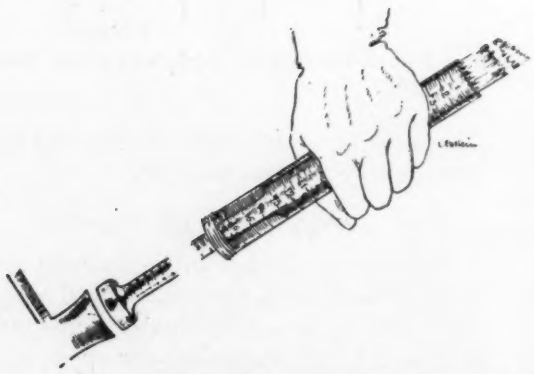
This new method of intra-articular arthrodesis offers technical, mechanical and biologic advantages. It is quite simple when adequate instruments are available; the operation is performed quickly when the local bone graft is taken out because the bed of the graft is already prepared. Since it is done by the extra-articular approach, the operation is less shocking; this is very important in older patients or in those with bad organic conditions. The incisions are just large enough to allow exposure of cortical bone at the place where we intend to start drilling. There is no need for large incisions or un-











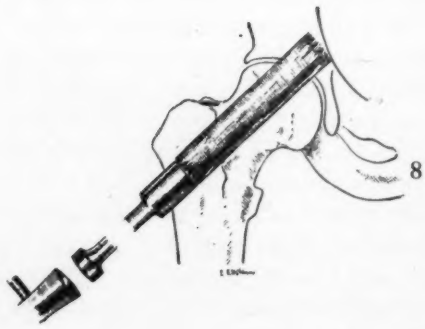


FIG. 3. Groove in the cortex of the femur.
FIG. 4. Introduction of the tubular saw.
FIG. 5. Penetration of the saw into the wall of the acetabulum.
FIG. 6. Cancellous bone graft is brought out from the acetabulum.
FIG. 7. Grafts are pushed out.
FIG. 8. Graft is placed in its bed.

dermining of large flaps; these only lengthen the operation unnecessarily, predispose toward shock and cause infection.

This technic does not impair the blood supply of the epiphysis. We know that the head and neck of the femur obtain their blood supply from the capsule and ligamentum teres, and it is necessary to cut them widely in intra-articular arthrodesis in order to expose completely the articular surfaces to be excised. The blood supply of the head and neck of the femur is impaired by this and a delay or even no fusion of articular surfaces may occur.

With this technic we take out the graft and at the same time partially excise the articular surfaces; it is done on the axis of movement of the joint where the mechanical action is stronger. We believe the bone graft used to be the best from a mechanical as well as biologic point of view. There is no need of bringing bone grafts far from the site of the arthrodesis. Since we employ local bone graft with its lamellas already accustomed to mechanical strain and since this graft is cylindrical with a large diameter, it works as an internal fixation of the arthrodesis. There is no need for internal metallic fixation as the Smith-Petersen nail. It is the most biologic means of internal fixation we can employ.

When excising articular surfaces it is the aim of the surgeon to join cancellous bone. With the proposed technic we reach this goal without excising articular surfaces and, therefore, without shortening the limb. The mobilization of a local cancellous bone graft improves the blood

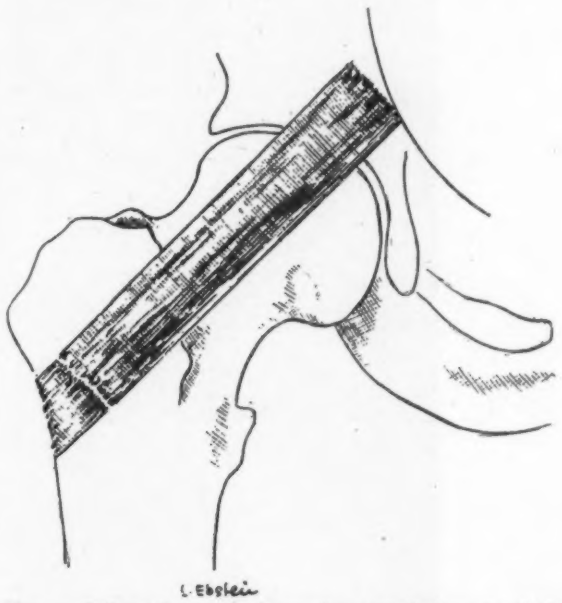


FIG. 9. When the graft from the acetabulum is withdrawn in one block, it is used to form the bed.

10 11

FIG. 10. Case 1. February 3, 1946, before operation.
FIG. 11. Case 1. July 18, 1946, final result.

12 13

14 15

FIG. 12. Case II. July 10, 1946, before operation.
FIG. 13. Case II. Notice penetration of instrument (A) into the acetabulum after passing through the femoral neck and head.
FIG. 14. Case II. At the end of the operation; notice the graft from the neck of the femur in the wall of the acetabulum and the graft from the acetabulum in the neck of the femur.
FIG. 15. Case II. January 2, 1947, final result; radiologic fusion.

supply which is good for the take of the graft. In addition the graft is placed in the bed of cancellous bone biologically similar and with good blood supply which provides easier fusion; also, the period of immobilization is short because of the quick take of the graft.

CASE REPORTS

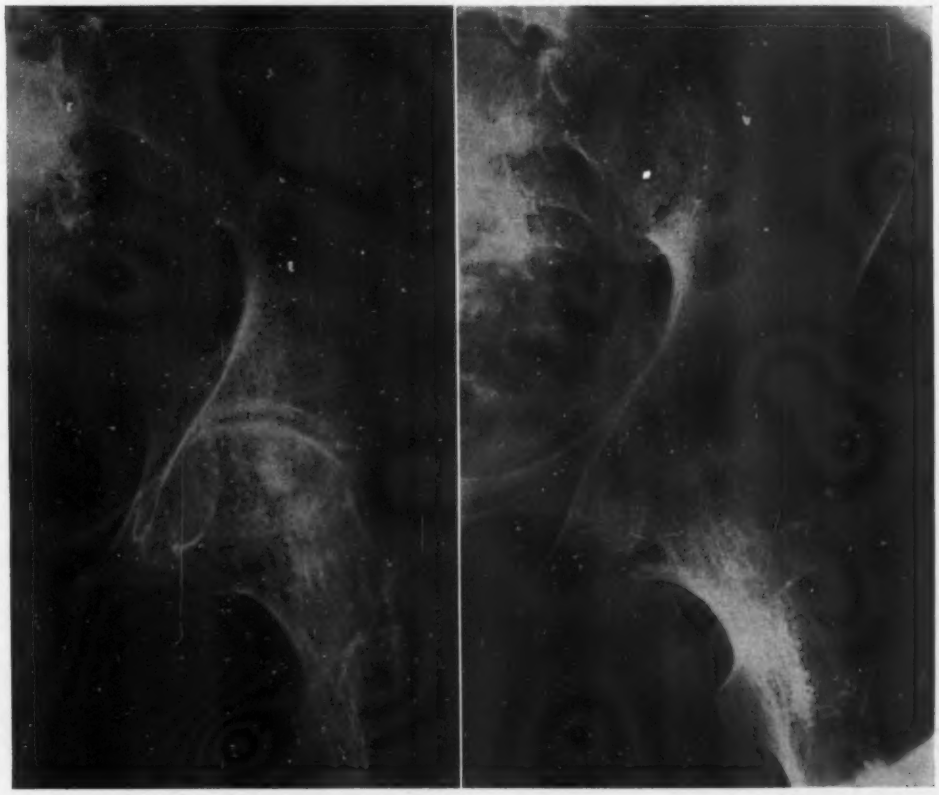
CASE I. M. N. C., a twenty-two year old male, had palsy of the muscles of the right shoulder and arm, sequelae of poliomyelitis. (Fig. 10.)

The upper extremity of the humerus was exposed through a small vertical incision, starting on the acromion after divulsion of fibers of the deltoid muscle. An intra-articular arthrodesis was performed on February 4, 1946, by the proposed technic. There were no abnormalities during the postoperative period. The patient had a shoulder spica until May 5, 1946, when it was removed and active movements were started. Roentgenograms on July 18, 1946, revealed union of arthrodesis. (Fig. 11.)

CASE II. L. B., a twenty-seven year old male, presented a painful left coxa plana, sequela of osteochondritis juvenilis. X-rays showed coxa plana with subluxation of femoral head. (Fig. 12.) Hip arthrodesis was proposed

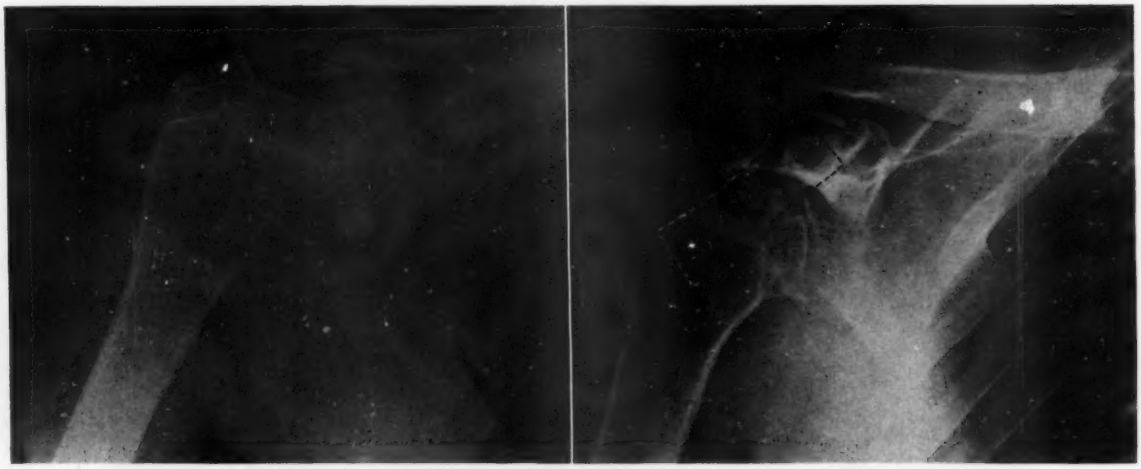
16 17

FIG. 16. Case III. September 13, 1946, shows graft from the neck of the femur going into the wall of the acetabulum.
FIG. 17. Case III. July 7, 1947, radiologic fusion.



18 19

FIG. 18. Case IV. September 15, 1946, before operation.
FIG. 19. Case IV. December 19, 1946, final result; radiologic fusion.



20 21

FIG. 20. Case v. October 10, 1946, before operation.
FIG. 21. Case v. March 19, 1947, final result; radiologic fusion.

and the operation was performed on August 30, 1946. In this case the graft of the acetabulum was taken out with part A. (Figs. 13 and 14.) A hip spica was applied. On January 2, 1947, the plaster was removed. The patient was discharged with clinical and radiologic fusion of the hip. (Fig. 15.)

CASE III. M. N., a male aged twenty-three, had osteoarthritis of the left hip with severe pain. On September 13, 1946, arthrodesis was performed using the proposed technic (Fig. 16); a hip spica was applied. There was clinical fusion on July 7, 1947, and painless weight-bearing. (Fig. 17.)

CASE IV. H. P., a male eighteen years of age, had osteoarthritis of the left hip with adduction and flexion contracture, with acute pain. (Fig. 18.) Manual reduction of the contracture and arthrodesis were performed on September 20, 1946; a hip spica was applied. On December 19, 1946, the plaster was removed. X-rays showed fusion of the hip. (Fig. 19.) There was painless weight-bearing.

CASE V. E. B., a forty-nine year old male, had paralysis of the right shoulder due to severe neuritis of the axillaris. (Fig. 20.) On October 28, 1946, arthrodesis was done and a shoulder spica was applied for four months. On March 19, 1947, x-rays showed solid fusion of the shoulder. (Fig. 21.)

ACUTE ABDOMINAL EMERGENCIES*

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IT is with the intention of offering an outline for organized thinking when confronted with an acute abdominal emergency that we present this paper. The senior author[1] discussed the details of diagnosis and treatment of the most frequent acute surgical emergencies of the abdomen in 1940. However, when subsequently speaking on this subject before various groups he has been impressed by comments that organization of the subject in outline form would be greatly appreciated by doctors who have been separated from academic study by years of practice.

We suggest approaching the entire subject of the acute condition of the abdomen by concentrating on the general symptoms of pain, vomiting and bowel changes in taking the history. We subdivide the topic of pain into onset and location, after Cope,[2] determining whether the onset is sudden or insidious. We also evaluate distribution of pain as to colic locations, top of shoulder and referred cutaneous hyperesthesia.

Vomiting can be related to severe irritation of the nerves of the peritoneum or mesentery, obstruction of an involuntary muscle tube or action of absorbed toxins upon the medullary centers. A correlation to one of these mechanisms can usually be made.

The evaluation of bowel changes must include a stethoscopic examination for increase, decrease or absence of peristaltic sounds as well as taking a history for bloody and tarry stools or diarrhea with hypogastric pain and tenderness. Our suggested outline for evaluating acute abdominal emergencies is as follows:

GENERAL SYMPTOMS OF AN ACUTE CONDITION OF ABDOMEN

Pain

1. Onset
   - A. Sudden
     - 1. Producing syncope
       - (a) Men: Acute pancreatitis
         Ruptured peptic ulcer
       - (b) Women: Also ruptured ectopic gestation
     - 2. Not producing syncope
       - (a) Colics (in tube structures and stomach associated with restlessness)
         Intestinal
         Biliary
         Ureterorenal
         Uterine-tubal
         Pancreatic
       - (b) Hemorrhage
         Spleen
         Liver
         Intestines
         Kidneys
         Cysts (ovarian, pancreatic, mesenteric, etc.)
         Bladder
         Ruptured Aneurism (syncope from shock)
       - (c) Emboli, thrombosis and infarction
         Mesentery
         Spleen
         Liver
         Iliac vessels
   - B. Insidious
     - 1. Inflammatory lesions
       - (a) Becoming obstructive
         Appendicitis
         Cholecystitis
         Acute hydronephrosis or pyelitis
         Salpingitis
         Pyometritis
         Stenosing duodenal ulcer
         Diverticulitis (Meckel's or colon)
         Regional ileitis
       - (b) Not obstructive
         Acute gastroenteritis
         Ulcerative colitis
         Mesenteric lymphadenitis
         Acute cystitis
         Pancreatitis
         Peritonitis (chemical or infectious)
         (Movement increases pain)

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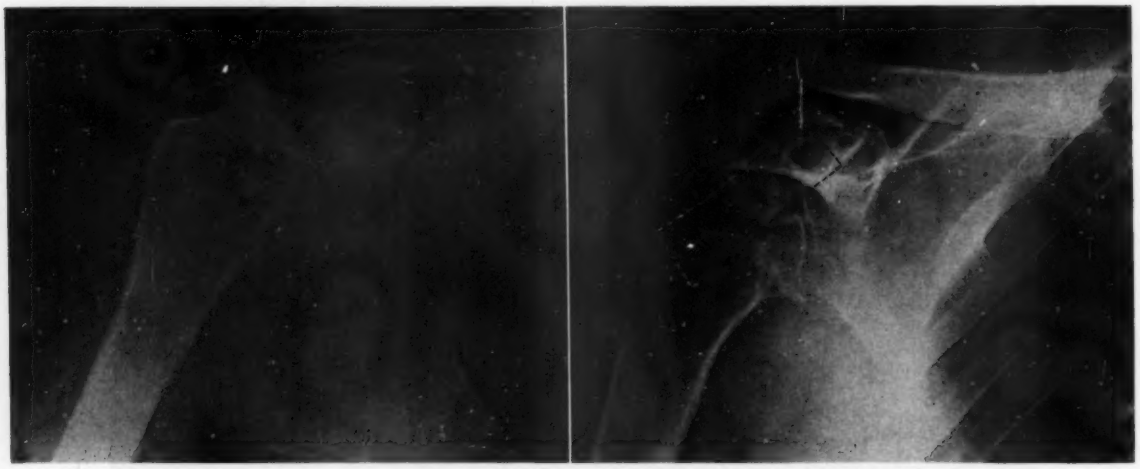

20 21

FIG. 20. Case v. October 10, 1946, before operation.
FIG. 21. Case v. March 19, 1947, final result; radiologic fusion.

and the operation was performed on August 30, 1946. In this case the graft of the acetabulum was taken out with part A. (Figs. 13 and 14.) A hip spica was applied. On January 2, 1947, the plaster was removed. The patient was discharged with clinical and radiologic fusion of the hip. (Fig. 15.)

CASE III. M. N., a male aged twenty-three, had osteoarthritis of the left hip with severe pain. On September 13, 1946, arthrodesis was performed using the proposed technic (Fig. 16); a hip spica was applied. There was clinical fusion on July 7, 1947, and painless weight-bearing. (Fig. 17.)

CASE IV. H. P., a male eighteen years of age, had osteoarthritis of the left hip with adduction and flexion contracture, with acute pain. (Fig. 18.) Manual reduction of the contracture and arthrodesis were performed on September 20, 1946; a hip spica was applied. On December 19, 1946, the plaster was removed. X-rays showed fusion of the hip. (Fig. 19.) There was painless weight-bearing.

CASE V. E. B., a forty-nine year old male, had paralysis of the right shoulder due to severe neuritis of the axillaris. (Fig. 20.) On October 28, 1946, arthrodesis was done and a shoulder spica was applied for four months. On March 19, 1947, x-rays showed solid fusion of the shoulder. (Fig. 21.)

ACUTE ABDOMINAL EMERGENCIES*

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IT is with the intention of offering an outline for organized thinking when confronted with an acute abdominal emergency that we present this paper. The senior author[1] discussed the details of diagnosis and treatment of the most frequent acute surgical emergencies of the abdomen in 1940. However, when subsequently speaking on this subject before various groups he has been impressed by comments that organization of the subject in outline form would be greatly appreciated by doctors who have been separated from academic study by years of practice.

We suggest approaching the entire subject of the acute condition of the abdomen by concentrating on the general symptoms of pain, vomiting and bowel changes in taking the history. We subdivide the topic of pain into onset and location, after Cope,[2] determining whether the onset is sudden or insidious. We also evaluate distribution of pain as to colic locations, top of shoulder and referred cutaneous hyperesthesia.

Vomiting can be related to severe irritation of the nerves of the peritoneum or mesentery, obstruction of an involuntary muscle tube or action of absorbed toxins upon the medullary centers. A correlation to one of these mechanisms can usually be made.

The evaluation of bowel changes must include a stethoscopic examination for increase, decrease or absence of peristaltic sounds as well as taking a history for bloody and tarry stools or diarrhea with hypogastric pain and tenderness. Our suggested outline for evaluating acute abdominal emergencies is as follows:

GENERAL SYMPTOMS OF AN ACUTE CONDITION OF ABDOMEN

Pain

1. Onset
   - A. Sudden
     - 1. Producing syncope
       - (a) Men: Acute pancreatitis
         Ruptured peptic ulcer
       - (b) Women: Also ruptured ectopic gestation
     - 2. Not producing syncope
       - (a) Colics (in tube structures and stomach associated with restlessness)
         Intestinal
         Biliary
         Ureterorenal
         Uterine-tubal
         Pancreatic
       - (b) Hemorrhage
         Spleen
         Liver
         Intestines
         Kidneys
         Cysts (ovarian, pancreatic, mesenteric, etc.)
         Bladder
         Ruptured Aneurism (syncope from shock)
       - (c) Emboli, thrombosis and infarction
         Mesentery
         Spleen
         Liver
         Iliac vessels
   - B. Insidious
     - 1. Inflammatory lesions
       - (a) Becoming obstructive
         Appendicitis
         Cholecystitis
         Acute hydronephrosis or pyelitis
         Salpingitis
         Pyometritis
         Stenosing duodenal ulcer
         Diverticulitis (Meckel's or colon)
         Regional ileitis
       - (b) Not obstructive
         Acute gastroenteritis
         Ulcerative colitis
         Mesenteric lymphadenitis
         Acute cystitis
         Pancreatitis
         Peritonitis (chemical or infectious)
         (Movement increases pain)

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2. Neoplasms
3. Post-trauma
4. Abscesses

II. Location of Pain
- A. Usually over the affected organ
- B. Radiation to top of shoulder (either supraspinous fossa, over acromion, over clavicle or in subclavicular fossa)
  1. Cholelithiasis (radiating from right subscapular area)
  2. Ruptured spleen (left)
  3. Subphrenic abscess
  4. Perforated peptic ulcer
  5. Diaphragmatic pleurisy
  6. Acute pancreatitis (radiates from midline back)
  7. Liver abscess
  8. Appendicitis with generalized peritonitis
- C. Colics
  1. Small intestinal
     Epigastric and umbilical (T_9 to T_{11})
  2. Large intestinal
     Hypogastric (T_{11} to L_1)
  3. Biliary
     Right subcostal at midclavicular line radiating to subscapular (T_8)
  4. Renal
     Loin, radiating to corresponding testicle (L_1, L_2)
- D. Referred cutaneous hyperesthesia
  1. Present in one-half the cases of acute abdominal condition
  2. May be referred to skin level of same spinal nerve innervating the pathologic organ (e.g., cutaneous level of hyperesthesia, associated with visceral peritoneal irritation of appendicitis)

Vomiting

Causes
1. Severe irritation of the nerves of the peritoneum or mesentery
   Examples:
   (a) Perforated peptic ulcer (irritation of peritoneum)
   (b) Acute pancreatitis (reflex stimulation of coeliac plexus)
   (c) Twisted ovarian cyst or strangulated bowel (sympathetic nerve stimulation)
2. Obstruction of an involuntary muscle tube
   Examples:
   (a) Biliary ducts
   (b) Ureter
   (c) Uterine canal
   (d) Intestine
3. Action of absorbed toxins upon the medullary centers

Bowel Changes

1. Peristaltic sounds usually decreased or absent, with obstipation
   (a) Peritonitis (paralytic ileus)
   (b) Intra-abdominal hemorrhage
2. Peristaltic sounds usually increased, without diarrhea
   (a) Mechanical obstruction (tinkles and rushes sometimes audible)
3. Peristaltic sounds usually increased, with diarrhea
   (a) Acute gastroenteritis
   (b) Dysenteries
4. Hypogastric pain and diarrhea followed by hypogastric tenderness and constipation are suspicious of a pelvic abscess and/or pelvic appendicitis
5. Bloody or tarry stools with acute abdomen indicate intragastrointestinal hemorrhage

CONDITIONS REQUIRING EMERGENCY SURGERY

I. Acute Trauma
- A. Non-penetrating
  1. Severe crushes
  2. Sharp, circumscribed blow (falls, animal kicks, etc.)
  3. Tear of visceral attachments or organ capsules (spleen, liver, kidney, intestines)
- B. Penetrating (stab, gunshot, pitchfork, etc.)
  1. Pneumothorax or hemopneumothorax must be differentiated
  2. Wounds of entrance and exit in intestinal tract must be located unless missile is in lumen.

II. Acute Appendicitis
III. Ruptured Peptic Ulcer
IV. Acute Mechanical Bowel Obstruction
- A. Strangulated hernia
- B. Adhesions
- C. Carcinoma
- D. Intussusception
- E. Volvulus
- F. Gallstone or foreign body[3]
- G. Regional ileitis (rarely)

V. Ruptured Ectopic Pregnancy
VI. Twisted (or Hemorrhage into) Ovarian Cyst
VII. Mesenteric Thrombosis
VIII. Abscesses
- A. Subdiaphragmatic
- B. Diverticular
- C. Liver
- D. Appendiceal
- E. Pelvic

IX. Ruptured Intestinal Ulcers (Typhoid, Amebic, etc.) or Persistent Hemorrhaging Gastrointestinal Ulcers

x. Ruptured Gallbladder
xi. Emboli of Iliac Arteries

MEDICAL CONDITIONS SIMULATING ACUTE ABDOMINAL EMERGENCIES

1. Pneumonia and/or diaphragmatic pleurisy
2. Acute gastroenteritis (food poisoning)
3. Mesenteric lymphadenitis (children)
4. Acute cardiac conditions
   (a) Coronary occlusion
   (b) Angina pectoris
   (c) Cardiac failure with congested liver
   (d) Acute pericarditis
5. Acute pancreatitis
6. Ruptured corpus hemorrhagicum
7. Mittelschmerz
8. Tabetic crisis
9. Lead poisoning
10. Aneurysm, dissecting or fusiform
11. Hepatitis
12. Influenza
13. Periarteritis nodosum
14. Tuberculous peritonitis
15. Typhoid fever
16. Diabetes mellitus (impending coma)
17. Abdominal allergy
18. Malaria
19. Other conditions include
    Interstitial nephritis
    Pyonephrosis
    Hemolytic jaundice
    Acute osteomyelitis of dorsal or lumbar vertebra
    Pott's disease in children
    Herpes zoster
    Henoch's purpura
    Sickle cell anemia
    Splenomedullary leukemia
    Subarachnoid hemorrhage
    Acute porphyria and others

COMMENTS

It is important to stress that the colics are produced by distention of obstructed tube structures (with fluid or gas) causing paroxysms of excruciating pain so that the patient writhes and doubles up. This picture is in sharp contrast to peritonitis in which the patient desires to lie quietly as any motion of the abdomen produces increased pain.

Concerning the onset of pain in hemorrhage into the spleen it should be remembered that the pain may be delayed as long as several days following trauma to the abdomen. For example, a "splenic cake" may form following a ruptured spleen with vague symptoms. The sudden onset of severe pain may then begin when intra-abdominal bleeding recurs as partial separation of the "splenic cake" occurs. In our experience the delayed onset of pain is nevertheless still sudden although it may conceivably be of the insidious type (as we have indicated under the post-trauma heading in the outline).

We do not consider regional ileitis an acute surgical emergency although it has a phase producing partial mechanical bowel obstruction among its four progressive stages, namely, simulating appendicitis, simulating ulcerative colitis, mechanical obstruction and formation of fistulas. Since it will occasionally be diagnosed inadvertently as an acute appendicitis and not be discovered until operation, we are in agreement with the treatment of closing the abdomen and doing elective surgery at a quiescent stage. In case an operation is inadvertently performed upon a patient with an acute pancreatitis (usually avoidable by thinking of the diagnosis and taking a serum amylase as soon as possible after the onset of pain), it has been our policy to drain the lesser peritoneal sac only and not perform even a cholecystostomy. We believe the less surgery performed, the better the patient's prognosis.

Concerning the diagnosis of acute appendicitis we recommend as useful the eliciting of a history for the sensation of "gas stoppage" at the very onset of the attack. This concept was reported by Keyes[4] and merely involves routinely asking the patient the following three questions: "At the onset of this attack did you have a sensation of gas stoppage in your bowels?" "Did you feel if you could pass gas that you would be relieved?" "Were you relieved when you were able to pass gas through your rectum?" A patient with acute appendicitis presumably answers the first two questions in the affirmative and the third in the negative. Since we have found that it is indeed true for the majority of our patients, we think it worth remembering in the taking of the history. However, there are always a few cases in which these symptoms will not be present as indicated so that they cannot be taken as pathognomonic. As always we must warn that the diagnosis of acute appendicitis can at times be the most difficult one to make preoperatively in surgery.

One suggestion that we have found very helpful when operating upon a patient with ruptured peptic ulcer, is to have the patient swallow one grain of methylene blue preoperatively. The presence of the dye in the free peritoneal fluid immediately relieves the mental

hazard of the surgeon as to whether the diagnosis is correct. Also, on one occasion it permitted us to localize an ulcer on the dorsal (retroperitoneal) portion of the duodenum that otherwise might easily have been missed.

Concerning the medical conditions simulating an acute surgical adbomen mesenteric lymphadenitis in children is often most difficult to distinguish from acute appendicitis. We believe it worth recording what most surgeons know by experience, namely, that this disease usually improves following removal of the appendix. There have been occasions when we have removed an appendix in the face of a presumptive diagnosis of mesenteric lymphadenitis, with persistent, severe, intermittent attacks, especially when a mental hazard exists in the minds of the parents and the doctor that one of these many attacks might really be appendicitis, and a ruptured appendix might then result from conservative treatment. This method of management in all cases has been chosen and approved by the parents (although in many cases it has not been more than a prophylactic appendectomy) and has frequently been followed by complete relief of symptoms.

CONCLUSION

The following general axioms[2] we agree are well worth remembering in acute abdominal emergencies:

1. Severe abdominal pain of six hours' duration in a previously well patient usually indicates surgical intervention.
2. If any patient with abdominal pain is found to have a temperature of 104° to 105°F. at the onset of illness, the thorax or kidney is very likely the seat of the disease.
3. A normal pulse does not necessarily indicate a normal condition of the abdomen, especially in the early stages of an abdominal emergency.
4. Irritation of the pelvic nerves causes no abdominal wall rigidity.
5. Movement and pressure increase pain in peritonitis but afford some measure of relief in colic.
6. The stethoscope is as important in surgery for abdominal auscultation as it is in internal medicine for chest auscultation.

SUMMARY

A logical method for organizing one's thinking when confronted with an acute abdominal emergency is presented in the hope that earlier correct diagnoses may be facilitated.

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PAPILLOMAS OF THE COLON AND RECTUM*

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THE most infrequently seen of the benign tumors of the colon and rectum is the papilloma. The papilloma or villous tumor is also termed papillary tumor, villous polypus, papillary adenoma or papillary polypus.[1] It is also called a villoma on occasion and the term "villous," while purely descriptive, is one of the most common names used in referring to this type of tumor.

This uncommon lesion is essentially one of adult life and its sex distribution is about equal. The great majority of papillomas occur in the rectum and pelvic colon, but they have also been described as occurring in the transverse colon[2] and descending colon.[7] Papillomas of the stomach[3,5,6] and gallbladder[10] have also been reported in the literature, and it is well known that they also occur in the larynx and urinary bladder.

Signs and Symptoms. The most prominent signs and symptoms are, namely, the production of mucus, usually in quantities, resulting in frequent, thin and watery passages; tenesmus and bleeding. Pain is not present, or if it is, it is usually in the form of tenesmus.[1] The large secreting surface of the tumor, covered with hyperactive cells, accounts for the mucus. The tenesmus is a result of the mucus, the tumor itself or of both. If the tumor is situated in the rectum, bright red blood may be noticed with a movement; or due to the friability of the tumor, an actual hemorrhage may occur. Protrusion may sometimes occur if the tumor is situated low in the rectum or if it is bulky; signs and symptoms of obstruction may be noted if it is situated at the rectosigmoidal junction or higher in the colon. At this level too, i.e., at the rectosigmoid, the tumor may cause an intussusception, a condition which was present in one of the cases herein described.

Signs and symptoms of papillomas may be present for a long time, even over a period of years, in contradistinction to most malignancies of the bowel.

Diagnosis. With its possibility kept in mind, a papilloma may be suspected from the history. On digital examination a characteristic soft, smooth "feel" is encountered. In almost every case there is a sessile base which is not indurated unless it has undergone malignant degeneration.

When viewed through an endoscope there may be a large amount of mucus present, so that a clear view may not be obtained unless a suction apparatus is used. The tumor is reddish or reddish grey in color, with numerous finger-like processes projecting from its base. Mere instrumentation may incite fresh bleeding because the tumor is friable.

Biopsies should be obtained from several areas for an accurate microscopic diagnosis.

When the tumor is situated beyond the reach of the sigmoidoscope, x-ray must be used for a diagnosis, and such filling defects are extremely difficult to differentiate from those of carcinomas.

Pathology. The papilloma almost always is sessile; it is rarely pedunculated. Numerous villi project from its base. The tumor is limited to the mucous membrane, unless it has undergone malignant degeneration, and it may be moved somewhat over the underlying musculature of the bowel wall. Papillomas may vary in size from that of a small nodule to a large tumor. The larger tumors are located in the rectum because it is so much more capacious, and they tend less to cause obstruction in this location. They may occur singly, or may be multiple and may cover a wide area of the mucous membrane.

Microscopically, the supporting connective tissue of the villi is quite vascular, and the villi are covered with high columnar epithelium. A general papillary appearance is seen throughout. (Figs. 1, 2 and 3.)

These tumors have a low grade of malignancy when they do degenerate, which happens in about 40 per cent of the cases.[8] They usually

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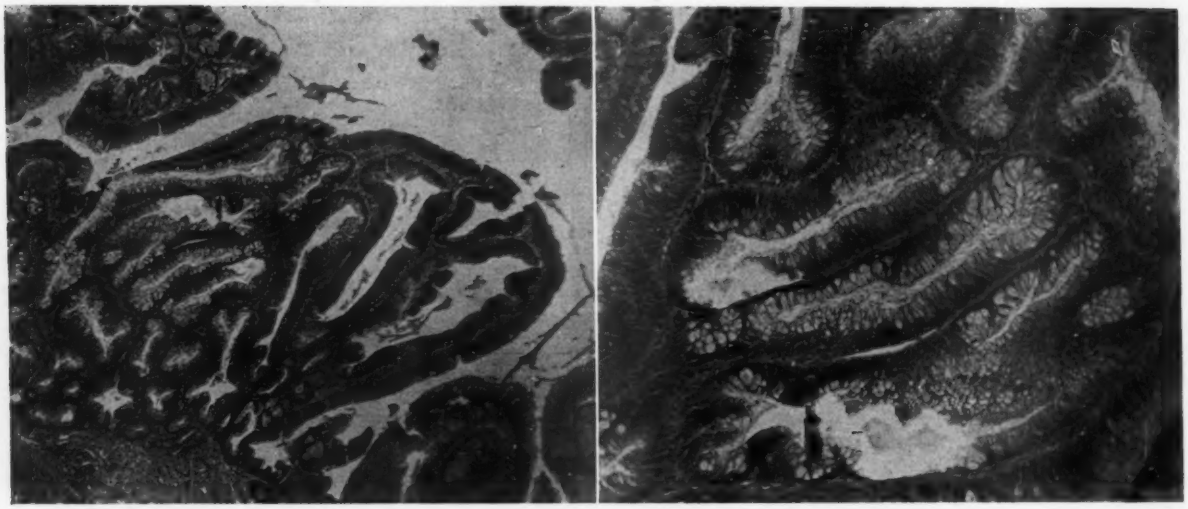

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FIG. 1. Case VII. The mucous membrane is intact although only a small portion of it is seen in the lower left hand corner. The papillary characteristics are prominent and there is little differentiation. × 40.
FIG. 2. Case VII. Section under higher magnification; several mitoses are present but the general architecture is well preserved. × 100.

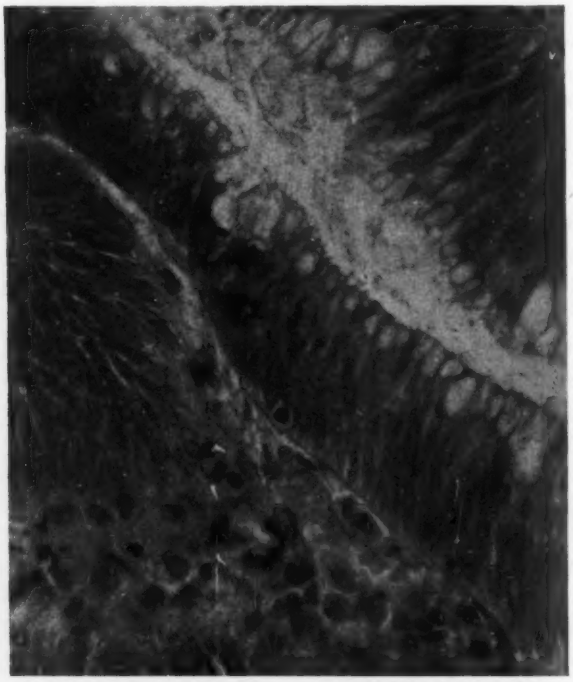

FIG. 3. Case VII. Section under still higher magnification; mitotic figures are more evident in this section. × 430.

do not metastasize, unless they become malignant, but do have a tendency to recur unless completely eradicated.

If completely eradicated the prognosis is good.

Treatment. Because of the high degree of potential malignancy possessed by these tumors, they should be treated as premalignant or outright malignant lesions. Local excision may suffice or the tumor may be destroyed by cautery, electrocoagulation or even deep x-ray or radium.[11] However, the latter methods preclude an accurate diagnosis of the base of the tumor. Total excision, including normal adjacent tissue about the base, is probably the treatment of choice.

When the tumor is situated in the pelvic colon or higher, segmental resection is probably best. When the tumor is situated in the rectum, an effort should be made to preserve the rectum. If, however, a wide area of the mucosa is involved which after local excision might result in a stricture upon healing or it is suspected that the tumor has invaded the bowel wall, the rectum should be removed. If the tumor cannot be excised locally via the anal canal, a posterior proctotomy may be done.

The method of treatment may vary, therefore, and depends upon the histologic picture, situation and extent of the tumor, and the general condition of the patient.

Since 1941 nine patients with papilloma of the rectum or pelvic colon were treated at St. Mary's Hospital Group, St. Louis, Missouri. The following is a brief presentation of these patients:

CASE REPORTS

CASE 1. O. T. S., a male age sixty-nine, was admitted to the hospital on January 29, 1941.

He complained of diarrhea, i.e., three to four bowel movements per day, tenesmus and bright red bleeding after a movement. There was a weight loss of 15 pounds in two years. There was no recent change in the bowel habit and he had a more or less chronic diarrhea for one year prior to admission.

He had been in the hospital four months previously, with the same signs and symptoms. At that time a proctoscopy was done, as well as a barium enema, and a diagnosis of diverticulosis of the colon was made.

On January 31, 1941 proctoscopy revealed a new growth on the anterior wall of the bowel 6 inches above the anal verge. A biopsy was made, and the diagnosis was malignant papilloma.

On February 21st an abdominoperineal resection was done. The pathologic diagnosis was papilloma of the rectum with malignant change. The patient died of shock on the fourth postoperative day.

Case II. A. J., a female age fifty-one, was admitted to the hospital on October 13, 1943 and stayed until November 14th. This patient had a hemorrhoidectomy three years before admission and since the operation had noticed blood in her stools. She also noticed a bloody spotting on her clothing during exertion or after a long ride.

On October 14, 1943 proctoscopy revealed a tumor on the anterior wall of the bowel 10 inches above the anal verge. Its size and attachment were not visible through the instrument.

On October 23rd an abdominal laparotomy was done. A tumor the size of a walnut was found in the lumen of the sigmoid colon and was locally removed via a sigmoidotomy.

The pathologic diagnosis was papilloma of the sigmoid colon.

Case III. M. V., a female age fifty-six, was admitted to the hospital on April 6, 1945 and stayed until May 13th. This patient had a dull, persistent discomfort in the rectum of four months' duration, not related to bowel movement. For one month prior to admission she had several loose stools per day and frequently had very black stools.

On April 11th a barium enema showed a filling defect at the rectosigmoidal junction. On the twenty-fourth a sigmoidectomy with end-to-end anastomosis was done. The tumor had a sessile base and no enlarged regional lymph nodes were found.

The pathologic diagnosis was papilloma of the sigmoid colon (potentially malignant).

Case IV. J. F., a female age sixty-six, was admitted to the hospital on April 8, 1945 and stayed until the fourteenth. This patient had bloody spotting for several years. Several months before admission her back began to bother her and her rectum hurt. On examination there was a sessile polyp 2 inches in diameter, situated 1 inch above the anorectal line. It seemed to be attached firmly to the bowel wall though a previous biopsy did not reveal any malignancy at its base.

On April 9th the tumor was exteriorized through the anus and removed at its base via a cautery. The base was then thoroughly cauterized. The pathologic diagnosis was papilloma of the rectum.

The patient returned to the hospital on April 4, 1948. She had been free of symptoms until two months before this entry when she again noticed the same symptoms that she had had April 8, 1945.

On examination, April 5, 1948, there was a large, spreading, papillomatous mass extending three-quarters of the way around the mid-portion of the rectum. Numerous areas were biopsied. The pathologic diagnosis was papilloma of the rectum with malignant change. The tumor was destroyed by fulguration on April 14th.

She re-entered the hospital, June 16, 1948, because on examination, although symptom-free, the tumor had recurred.

On examination there was a polypoid mass 1 cm. in diameter on the left posterior wall, 2.5 cm. above the anorectal line. On June 17th the tumor was thoroughly destroyed with a cautery along with a portion of normal-appearing surrounding mucous membrane.

Case V. H. W., a female age sixty-eight, was admitted to the hospital on June 6, 1947 and stayed until August 15th. This patient had three to four thin, watery stools per day for approximately eight years. There were no other signs or symptoms. On examination there was a soft mass on the anterior wall of the rectum at the level of the tip of the examining finger. On proctoscopy there was a sessile polyp on the anterior wall of the upper rectum. A biopsy was made. The pathologic diagnosis was papilloma with malignant change.

On June 13th, 1947, a proctotomy was done with an attempted local removal of the tumor. However, it completely encircled the lumen and was very friable. An abdominoperineal resection was done, June 17th.

The pathologic diagnosis was papilloma of the rectum with malignant change. (No invasion of the stroma was seen.)

CASE VI. C. D., a forty-two year old male, was admitted on December 16, 1947 and stayed until January 4, 1948. About two years before admission to the hospital he noticed a change in bowel habit, when he developed five to six loose, watery stools per day. About two months before entry there was a mass which protruded at time of bowel movement, with streaks of blood on the toilet tissue. There was a second episode of diarrhea one year after the first; several months later he began to have alternate periods of diarrhea and normal bowel movements.

A gastrointestinal series and barium enema were negative.

On examination an irregular polypoid mass was felt in the upper rectum. On proctoscopy an ulcerating mass was seen at the level of the upper rectal valve. A biopsy was made.

The pathologic diagnosis was papilloma of the rectum with malignant change.

On December 20, 1947, an abdominoperineal resection was done. The pathologic diagnosis was papilloma of the rectum with malignant change. (In view of the size of the tumor, local excision was not possible.)

CASE VII. J. O'H., a seventy-four year old male, was admitted to the hospital on March 8, 1948 and stayed until May 29th. This patient had a history of bleeding per rectum for many years and tenesmus with loose, watery stools for three or four months prior to entry. He also had protrusion and three days previously could not reduce the mass, and hemorrhage began.

On examination there was a soft mass on the anterior wall of the lower rectum, approximately 6 cm. in diameter. The lower pole of the tumor was visible via an anoscope, and a biopsy was made. Sigmoidoscopy could not be done because of the large quantity of mucus present. A suction apparatus was not handy at the time and, therefore, a clear view of the tumor was not obtained. However, the clinical impression was that of a papilloma of the rectum.

The pathologic diagnosis was villous papilloma with early malignant change.

On March 15, 1948, an attempt was made to remove the tumor with an electric snare but was not completely successful. On the twenty-third a sigmoid colostomy was done. On April 6th a proctotomy was done, with local excision of the tumor including a margin of normal mucosa. The tumor was 7 by 5 cm., grossly limited to the mucosa and situated on the anterior wall of the lower rectum.

The pathologic diagnosis was papilloma of the rectum with early malignant change.

On April 27th a spur clamp was applied to colostomy. On May 6th the rectal wound, which had been left open to granulate, was entirely healed, with the formation of a slight elastic stenosis. On May 18th the colostomy was closed extraperitoneally. General and local conditions were good, August 3rd. No stenosis was present. April 28, 1949, there was no stenosis and no evidence of recurrence.*

CASE VIII. M. K., a female age fifty-six, was admitted to the hospital on October 18, 1948 and stayed until October 24th. Bright red bleeding per rectum of twelve years' duration, seen only on toilet tissue, and protrusion with bowel movement requiring digital replacement were the main signs. The protruding mass had increased in size in the twelve months prior to admission.

On October 21st there was a sessile mass 6 cm. in diameter on the anterolateral wall of the lower rectum, which did not seem to invade the rectal wall. It was delivered through the anus and excised locally along with a margin of normal mucosa. The pathologic diagnosis was papilloma of the rectum.

CASE IX. F. B., a female age fifty-nine, was admitted to the hospital on December 5, 1948 and stayed until January 9, 1949. Eight months before entry this patient had a hemorrhoidectomy. A barium enema at that time was reported negative. Following the operation she began to have tenesmus and frequently passed bloody mucus. Three weeks prior to entry she began to have signs and symptoms of intestinal obstruction.

Digital examination revealed a tumor high in the rectum. On December 5th a transverse colostomy was done. On the twenty-second a

* When the patient was seen February 7, 1950, the general and local conditions were good, with no evidence of recurrence.

laparotomy was done. There was a polypoid mass in the sigmoid that had intussuscepted into the rectosigmoid and upper rectum. A segmental resection was done, excising the mass, and an end-to-end anastomosis made.

The pathologic diagnosis was papillomatous polyp of the sigmoid colon with cytologic malignancy. On January 3, 1949, the colostomy was closed via a resection and end-to-end anastomosis.

All patients, with the exception of Case 1 are living and well and are symptom-free to date.*

COMMENTS

The pathologist may be of great help in the determination of the type of treatment of papillomas of the bowel. If the microscopic examination of the tumor reveals no invasiveness, even though "cytological malignancy" may be present, some form of local treatment is usually all that is needed. This applies more particularly to tumors located in the rectum or lower sigmoid colon, which can be watched periodically for evidence of recurrence. When these are beyond the reach of the sigmoidoscope, a segmental resection is safer, pathologically speaking.

SUMMARY

1. Papillomas of the colon and rectum are rather uncommon benign tumors.

2. They have a high degree of potential malignancy, are slow growing, tend to recur and do not metastasize unless they undergo malignant degeneration.

3. The treatment depends upon the microscopic picture of the tumor, its location, the extent of its growth and the general condition of the patient.

4. Nine cases of papillomas of the colon and rectum are presented.

* Five of the nine patients are from the service of Dr. Warren G. Marston of St. Louis, who kindly granted permission to present them.

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USE OF DOUBLE LUMEN TUBE IN GASTRIC SURGERY

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GASTRIC resection and other forms of surgery for lesions of the stomach can now be carried out with low mortality and a maximum of benefit to the patient. Such results are commonplace in clinics that have had sufficient experience with this type of surgery. However, there are opportunities for improvement and it has been my experience that the use of the double lumen tube has advantages that should be more widely recognized.

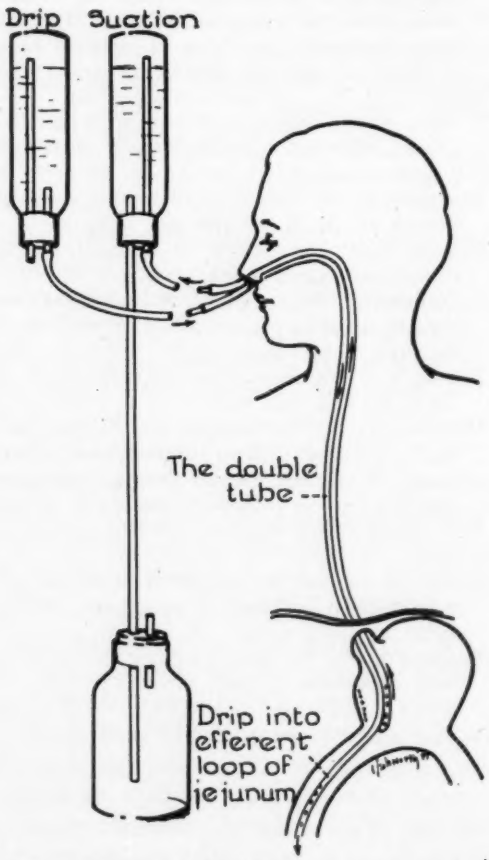

FIG. 1. Shows the double lumen tube in place and method of suction and drip.

The following description covers the main points to be considered in the use of this apparatus:*

* The tube used is the Miller-Abbott double lumen tube, No. P 9144, put out by Geo. P. Pilling & Son Co., Philadelphia, Pa.

Before the tube is used it is sterilized in formalin vapor. Prior to the administration of the anesthetic the tube is introduced into the stomach through the nares, using aseptic technic. It is held in place with adhesive and is connected with suction during the operation. A well lubricated tube and the use of sterile water for drinking by the patient facilitates the descent of the tube. (Fig. 1.)

After the stomach has been resected and before beginning the anterior row of sutures of the anastomosis between stomach and jejunum, the tube is removed from the fundus and passed into the efferent loop of the jejunum. No very aseptic method of carrying out this maneuver has been devised although this does not seem to offer an objection since no clinical evidence of peritoneal infection has been observed. The tube is sutured in place using No. 1 plain catgut suture and passing the suture through the tube and the posterior line of anastomosis. It has been found that the catgut will have been sufficiently absorbed after twenty-four to forty-eight hours to permit removal of the tube without difficulty. This suture is desirable in order to maintain the tube in position during the postanesthetic period and to prevent the tube from being regurgitated back into the stomach until normal peristalsis is established.

Immediately on return from surgery the tube ending in the stomach is connected with the suction apparatus and into the one in the jejunum. The drip is then started. The drip solution consists of: 800 cc. normal saline and 10 per cent glucose, 200 cc. of 15 per cent amino acids, 100 mg. ascorbic acid (vitamin C), 20 mg. thiamine hydrochloride (vitamin B), 5 mg. riboflavin and 50 mg. nicotinic acid. The solution is dripped in at the rate of forty drops per minute; this will insure the introduction of approximately 1,000 cc. every eight hours. Water is used alternately instead of normal saline.

Formerly 15 gr. of sodium sulfathiazole were introduced into the jejunum through the tube every four hours but this frequently resulted in the formation of a precipitate which plugged the tube. Sulfa has been discontinued and has

been replaced by 50,000 units of penicillin given hypodermically every three hours, which is continued for the first three postoperative days.

As soon as the patient comes out of the anesthesia, he is encouraged to drink water. There is no fear of damage to the suture lines so long as the suction works well.

The tube is generally left in place for seventy-two hours. The opportune time for its removal can be tested by clamping off suction and giving the patient fluids by mouth. If no discomfort is experienced by the patient after three hours and little fluid is obtained at this time by suction, the stoma is in all probability functioning adequately. Epigastric distress and recovery of the ingested fluid is evidence that the tube should be left in place.

COMMENT

From repeated experience it has been found that the successful use of the double tube depends to a great extent upon the intelligence of the attending nurses and their familiarity with this method. Detailed instruction along with a diagram of the tube in place and an explanation of what the apparatus is supposed to accomplish is kept on each floor of the hospital. This has been found of great help to the nursing staff. If the lumen of the tube is kept free, by frequent irrigations with small amounts of water when necessary, little trouble otherwise is to be expected.

The advantages to be gained by the double lumen tube, in my opinion, are many. In over 200 gastric resections in which this method has been used I do not believe any deleterious complications due to the tube have arisen. The tube is especially useful in total gastrectomies. It is sutured to the anastomosis between esophagus and jejunum and, I believe, is particularly useful in protecting the suture line.

Advantages. The stomach is kept decompressed and clean, thus relieving tension on suture lines. The patient receives adequate fluids and vitamins and considerable food. There is no necessity for intravenous medication unless it is believed advisable to administer blood or plasma. The tube into the jejunum helps prevent angulation at the site of anastomosis and the introduction of the drip into the jejunum activates early peristalsis which I believe is advantageous.

Disadvantages. Some individuals do not tolerate the tube well. However, this is considerably offset by the lack of necessity for giving intravenous fluids. The incidence of atelectasis following use of the tube is not, I believe, increased. However, when it is suspected that this has taken place or is impending, the tube is generally removed so that the patient can more easily clear out the bronchial tree.

Gastric resection is a procedure that is inevitably accompanied by discomfort to the patient. If the double lumen tube does make the patient more uncomfortable in some instances, it has, in my opinion, adequately justified its use by increasing the safety of the operation.

SURGICAL DEATH DUE TO HEPATIC EXHAUSTION

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IT is the occasional experience of many surgeons to have a patient die following operation under circumstances which defy explanation. Very often autopsy itself fails to reveal any apparent cause of death. In previous years pulmonary complications were incriminated as the underlying cause of death. When necropsy did not substantiate this antemortem impression, cardiac insufficiency was indicated. Present day studies have enabled us to suspect an organ hitherto exonerated as the agent producing death following operation. Hepatic physiology captivated our interest in a study of the etiology of thyroid crisis.[1] Subsequent observations resulted in the postulated relationship between hepatic anoxia and postoperative shock. In the course of our study of hepatic physiology, liver function tests were performed. The information revealed plus our own clinical observations has enabled us to arrive at certain conclusions.

Initially it must be stated that many surgical patients are subjected to operation without an adequate evaluation of their hepatic status. It is these patients who present the postoperative complications under discussion. For this reason it is assumed that these patients have insufficient hepatic reserve physiology. Although this liver impairment exists preoperatively, it is not sufficiently severe to interfere with the daily basal liver activity. In other words as long as the liver is not called upon to perform more than its basal necessity, no hepatic insufficiency is discerned. Under such circumstances it may be compared to the heart which has exhausted its reserve. No evidence of cardiac decompensation occurs until a new burden is thrown on the circulation. Similarly, the liver is able to maintain a standard pattern provided that a reserve capacity is not needed; however, when the patient is subjected to surgery, the liver has no reserve capacity for sustaining this new burden. Thus the liver permits the normal toxic substances absorbed from the intestinal tract to pass through undetoxified into the general circulation. These impurities plus toxic metabolites from necrotic liver cells overburden the kidneys which attempt to take over the duties of the liver.[2] When the kidneys are thus forced to assume the detoxifying function of the liver, this added physiologic necessity results in renal decompensation. Hence it can be appreciated that initial hepatic exhaustion produces renal insufficiency and death. Postmortem examination of these organs will demonstrate no specific pathologic process indigenous of hepatic exhaustion or renal insufficiency.

The most important concern of the surgeon in this situation is to determine and rectify if possible the underlying cause of liver dysfunction in surgical patients. Apropos of this problem, other authors have made valuable observations in this regard.[3,4] They have shown that hepatic physiology is markedly impaired when excessive lipid deposition occurs in this organ. A high protein level will diminish the susceptibility of the liver to noxious influences even if it has been the recipient of excessive fatty infiltration. Hyperproteinemia will protect liver function. The beneficial effects of a high carbohydrate intake is not based on glycogen storage but is due to the intimate relationship between fat and carbohydrate metabolism. Adequate carbohydrate intake assists in reducing the lipid content of the liver; hence the salubrious effects of a large carbohydrate intake on liver function.

An adequate nitrogen balance implies sufficient available exogenous protein. Protein protects the liver by reducing the lipid content of this valuable organ.[5] The need for an adequate protein balance to protect the liver thus becomes self-evident. An insufficient intake of dietary protein results in the loss of much of the original protein content. When the liver is low in available protein, an excessive deposition of fat is a necessary corollary.[5] This state of hypoproteinemia preoperatively is one of the major causes of postoperative hepatic impairment, exhaustion, and may eventually terminate in death.

Hepatic embarrassment may occur subse-

quent to other causes. Anoxia of the liver has been indicated as a factor in producing disturbed protein function of the liver. This disturbance results in hypoproteinemia which predisposes to shock and eventual death following surgical procedures. Death from hepatic anoxia closely simulates acute coronary occlusion. On many occasions postoperative patients have been subjected to electrocardiograms in an effort to identify the underlying cause for their shock-like state. At autopsy no cardiac condition has been in evidence. The real cause of death is hepatic exhaustion. The liver is exonerated on many occasions because no specific pathologic process categorizes this lesion. It must therefore be termed physiologic death because of the cessation of normal hepatic physiology. The process may be compared to death resulting from carotid-sinus syncope or that due to reflex pleural syncope. In these latter circumstances constitutional predisposition may lead to death. However, at autopsy no specific finding is available to categorize or identify this physiopathologic entity.

It is the primary purpose of this discussion to focus attention on the major role of the liver during the immediate postoperative period. When the cause of death following surgery cannot be definitely established, hepatic exhaustion should be considered. Death of this type can be avoided if sufficient preoperative evaluation of the liver is established. More specifically, the state of nitrogen balance must be evaluated by studying protein levels. Anoxia during and following operations must be avoided as much as possible. Whenever it is feasible or if doubt arises as to the status of hepatic physiology, a liver function test should be performed. This procedure should not be interpreted as being overcautious when one realizes that postoperative death may be avoided.

Attention is called to liver failure as a precipitating cause of death following surgery. Future studies on hepatic physiology will reveal that many postoperative complications previously inexplicable will be solved. Some future investigators undoubtedly will unravel this problem more clearly. The present purpose is to interest the surgeon in hepatic physiology sufficiently that he will study the liver preoperatively and thus perchance avoid a fatal postoperative complication.

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Streamlined Articles

SIMPLIFIED METHOD OF TREATING COMPRESSION FRACTURES OF THE LOWER BACK

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A SIMPLIFIED method is suggested for treatment of compression fractures of the lower back using the Zimmer clavicular strap in reduction and the application of plaster. The disadvantages of commonly used methods are compared with the one presented herein. This method has been used in only a limited number of cases. However, in all cases the reduction has restored the normal height of the anterior vertebral body. All patients have been allowed out of bed on the second day with only negligible discomfort from the cast. None have had any pain in the fracture site. The reduction has been maintained in all cases, as shown by follow-up x-rays. This, we believe, substantiates the efficiency of the cast applied by this method.

* * * *

DISADVANTAGES OF COMMON METHODS

Frames and bars do not provide the natural curvature of the vertebral column. The maximum amount of hyperextension is difficult to obtain. The frames and bars prevent the snug application of plaster thus being a factor in loss of reduction, especially with ambulation. The expense of such equipment makes it impractical for some to use.

Canvas slings across the chest or back cause a ridge in the soft tissues over which the plaster is applied. After the plaster sets there is a remaining ridge in the plaster which is apt to be most painful to the patient. The straps also are difficult to remove from beneath the plaster.

In the two-table technic the table supporting the shoulders prevents the application of plaster to a desired high level on the sternum. If the table is put as high as necessary to apply plaster properly, the pressure or stretch on the neck is hazardous in producing trauma to the trachea and possibly acute obstruction. This complication happens not infrequently with this method and prevents the deliberate administration of anesthesia without an intratracheal tube.

SUGGESTED METHOD

The patient has a Zimmer clavicular strap applied about his shoulders in a method as shown in Figure 1. A stout rope is tested with equal weight of the patient and then is quadrupled so as to provide a safety factor of four. The ropes are attached to a stable ceiling fixture and to the buckle of the strap. The patient's head is held in the anesthetist's lap at any angle necessary to maintain an adequate airway. (Fig. 2.) With the patient in the prone position the weight is then supported by the clavicular strap about the patient's shoulder and by a table at the level of the patient's thighs. The weight of the arms are supported in a neutral position by tables or assistants. By this method the operator has free access to manipulate the back by a "controlled" method. The right knee is placed beneath the symphysis pubis, the left hand is under the sternum, and the reduction is carried out with the right hand. (Fig. 3.) A light, snug-fitting plaster cast is applied, using felt padding along the vertebral column, the anterior upper part of the cast over the sternum, the symphysis and over the anterior iliac spines. (Fig. 4.)

Advantages of Method. This technic allows simple, unobstructed and deliberate administration of anesthesia without intubation. This in turn does away with the annoying possibility of having to turn the patient before the plaster has set properly. It allows snug application of plaster from the pubis to high sternum, which is necessary for maintenance of reduction. The

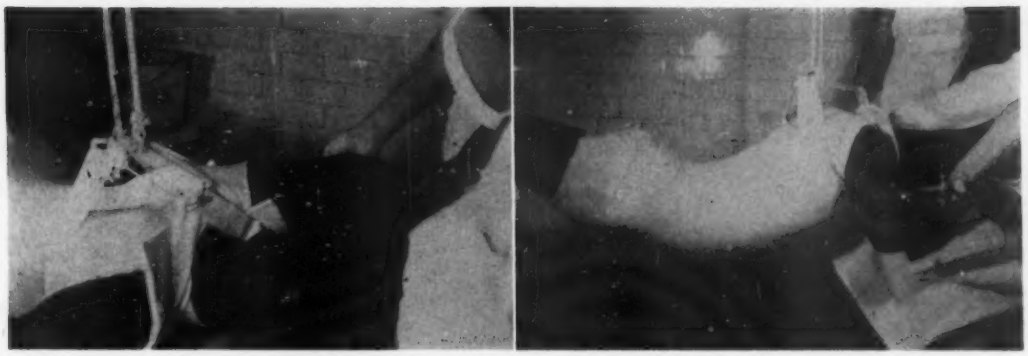

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FIG. 1. The Zimmer clavicular strap is reversed so that the buckle is located posteriorly rather than over the sternum; note the accessibility of the head for the anesthetist.
FIG. 2. Shows the natural curvature of the vertebral column and the ease with which a patient can be suspended until the plaster has set properly.

3 4

FIG. 3. The "controlled" method of reduction is shown; also, the adequate space for application of plaster is demonstrated.
FIG. 4. The light, tight-fitting cast is shown, which reaches from high sternum to cover the symphysis pubis.

maximum hyperextension is easily obtained, and the cast is fitted to the natural curvature of the back. The straps are easily removed after the application of plaster. This method is simple, and is applicable to any small hospital where the purchase of other equipment is not feasible.

Precautions. The operator must always be positive in this method as in others that there are no fractures of the posterior elements of the vertebral column before attempting any type of closed reduction in extension. The method is not used when the general condition or age of the patient contraindicates any type of closed reduction in extension. It is best to use abdominal pads or felt beneath the clavicular straps anteriorly to absorb the pressure of the straps across the front of the shoulders. The operator should personally check equipment before each case to insure maximum safety.

USE OF ULTRAVIOLET BLOOD IRRADIATION (KNOTT TECHNIC) IN BILIARY TRACT SURGERY*

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A SERIES of 336 patients is presented of which 110 consecutive unselected patients were treated preoperatively and postoperatively with ultraviolet blood irradiation. A marked reduction in the number and severity of postoperative complications in the patients treated with blood irradiation is shown.

* * * *

Because the treatment of gallbladder disease in a large percentage of cases resolves itself to surgical intervention and because of the relatively high incidence of complications attendant upon biliary surgery, a study of three and a half years of these postoperative complications was undertaken[10] with a concerted effort to alleviate them by ultraviolet blood irradiation therapy (Knott technic).† The selection of this type of therapy for a comparative study was made because of the correlation of its biochemical effects with the pathologic physiology of the complications, namely, (1) increase in oxygen absorption values,[2,6] (2) increase in opsonic index,[1] (3) inactivation of toxins and viruses,[3,8] and (4) control of various bacterial infections.[4,7,11–13]

UBI[5] consists of the withdrawing of a predetermined amount of blood from the patient, usually 1½ cc. per pound of body weight, and exposure of this blood after citration to selected wave lengths of ultraviolet rays produced by a Burdick water-cooled ultraviolet generator and immediately returning it to the blood stream of the patient. It is essentially a surgical procedure utilizing an apparatus which has been designed so that mechanical regulation of all factors and thorough precision with simple operation make the administration of this therapy a safe procedure.

A study of 336 consecutive patients undergoing biliary surgery in two parallel series was undertaken and carefully evaluated as to the incidence in age groups, pathologic diagnoses, surgical procedure, postoperative complications of distention, nausea and vomiting, thrombophlebitis[9] and phlebothrombosis, mortality and correlated studies of measures for control of these complications. In almost all cases a uniform preoperative preparation was done with a minimum of forty-eight hours' study and preparation preceding surgery. These studies included routine blood counts, blood chemistries, urine analyses, and x-rays. Special studies such as electrocardiograms, additional blood chemistries and liver function tests were done as indicated. Therapy was instituted as indicated to control dehydration, anemias, loss of electrolytes and severe infections.

Operations were performed under combined spinal anesthesia and sodium pentothal® analgesia in all but a few of the aged and severely toxic patients when local anesthesia or combination of sodium pentothal® anesthesia was used. Almost uniformly the surgical technic consisted of careful and thorough exploration of the common duct by manual palpation and incision and dilatory exploration in the cases of jaundice, with removal of calculi or dilation and plastic procedure in stricture or other obstruction. In these cases T tube drainage was instituted. The gallbladder was usually removed after the accepted manner by careful dissection of the cystic duct, dissection and ligation of the cystic artery and removal of the gallbladder from below upwards with a continuous suture closing the gallbladder bed. A drain was routinely placed in the gallbladder bed to the foramen of Winslow and brought out in the right subcostal region through a stab wound or through the incision. Appendectomy was done in all cases when feasible.

Postoperatively all the patients were treated with a view towards early activity, breathing

† UBI will be used hereafter for ultraviolet blood irradiation therapy (Knott technic).

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exercises, gradually increasing diets and treatment of complications as was indicated. Intravenous fluids were administered as indicated and vitamin and adjuvant therapy used as selected by the individual surgeon.

received two such treatments; the maximum number given was six. (Table I.)

Table I presents a classified review of 336 consecutive and unselected patients with biliary disorders with types of surgery per-

TABLE I

CLASSIFIED REVIEW OF CASES OF BILIARY DISORDERS WITH TYPES OF SURGERY PERFORMED

	Histopathologic and Surgical Diagnoses	Total Patients		Cholecystectomy		Cholecystectomy Appendectomy		Cholecystectomy Choledochostomy		Cholecystectomy Choledochostomy Appendectomy		Cholecystostomy		Choledochostomy	
		Irradiation		Irradiation		Irradiation		Irradiation		Irradiation		Irradiation		Irradiation	
		No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Acute	Cholecystitis			3								1			
	Cholecystitis and cholelithiasis			6	6	2	5						1		
	plus acute pancreatitis												2		
	plus diabetes mellitus												1		
	plus choledocholithiasis										1				
	Gangrenous cholecystitis			1											
	with perforation				1										
	plus cholelithiasis			2	2	3	1								
	Total	18	20	12	9	5	6				1	1	4		
	Percentage	8%	18.2%	66.6%	45%	27.7%	30%				5%	5.5%	20%		
Acute Receding	Cholecystitis			3	1	1						1			
	Cholecystitis and cholelithiasis			19	1	3	9						1		
	plus acute pancreatitis						1								
	plus choledocholithiasis							1			3				
	Empyema of gallbladder plus thrombophlebitis on admission												1		
	Total	28	17	22	2	4	10	1			3	1	2		
	Percentage	12.4%	15.4%	78.5%	11.7%	14.2%	58.8%	3.5%			17.6%	3.5%	11.7%		
Chronic	Cholecystitis			25	7	13	7					3			
	Cholecystitis and cholelithiasis			67	26	41	16	1				1			
	plus choledocholithiasis				1		2	2	3	1	1				
	plus acute pancreatitis												1		
	plus chronic pancreatitis			2	1							1			
	plus cancer pancreas							1			1	1	1		
	plus diabetes mellitus			1	1		2								
	Normal gallbladder			7	3	9		1				1		1	
	Stenosis common duct													1	
	Total	180	73	102	39	63	27	5	3	1	2	7	2	2	
	Percentage	79.6%	66.4%	56.6%	53.4%	35%	36.9%	2.7%	4.1%	.5%	2.7%	3.8%	2.7%	1.1%	
	Grand totals	226	110	136	50	72	43	6	3	1	6	9	8	2	0
	Percentage			60.1%	45.4%	31.8%	39%	2.6%	2.7%	.4%	5.4%	3.9%	7.2%	.8%	0%

The only addition to the accepted and indicated treatment of all patients was that of the use of UBI in the second series consisting of 110 consecutive and unselected patients. In this group on the day preceding operation the patients received UBI therapy. Subsequent UBI treatments were given routinely the day lowing operation and as indicated during the postoperative course. The average patient

formed over a period of three and a half years. Of this group 110 consecutive patients were given UBI. Among this group of non-irradiated patients 8 per cent presented an acute cholecystitis and 18.2 per cent of the irradiated patients fell into this same group. Appendectomies were performed upon 31.8 per cent of the non-irradiated group of patients and upon 39 per cent of the irradiated group. (Table II.)

Comparison studies of complications in biliary surgery in non-irradiated and irradiated patients were classified in Table II. The character and type of complications were evaluated as was the incidence in age groups. The most common complications were selected. These included excessive nausea and vomiting necessitating the use of gastric suction, excessive abdominal distention necessitating supplementary measures of control with the exception of the use of intubation, thrombophlebitis and phlebothrombosis, pulmonary infarction and mortality statistics. Acute cholecystitis was observed most frequently in the age group from fifty to fifty-nine in both series. Chronic cholecystitis appeared most frequently in the group from forty to forty-nine years of age in non-irradiated patients and from fifty to fifty-nine years in the group of irradiated patients.

Excessive nausea and vomiting necessitating the use of gastric intubation were used in 33.1 per cent of the non-irradiated patients and only in 2.7 per cent of those who had received UBI. This shows a substantial reduction in the complication of excessive nausea and vomiting postoperatively in the irradiated group. If we exclude completely 14.3 per cent or forty of the patients operated upon by two surgeons who use gastric suction routinely, it will be noted that 18.8 per cent of the non-irradiated group had gastric suction used of necessity.

In the non-irradiated group 28.8 per cent of the patients presented excessive abdominal distention as compared to 11.8 per cent in the irradiated group. The criteria used for this comparison were based on the use of stimulants to the parasympathetic nervous system and where two or more doses of drugs such as

TABLE II

COMPARISON STUDIES OF COMPLICATIONS IN BILIARY SURGERY IN NON-IRRADIATED AND IRRADIATED CASES

Gross Diagnosis	Age	No. of Patients Operated Upon		Excessive Vomiting (Gastric Suction)		Abdominal Distention		Excessive Temperature Elevation		Thrombophlebitis, Phlebothrombosis		Pulmonary Infarction		Mortality	
		Non-irradiated	Irradiated	Non-irradiated	Irradiated	Non-irradiated	Irradiated	Non-irradiated	Irradiated	Non-irradiated	Irradiated	Non-irradiated	Irradiated	Non-irradiated	Irradiated
Acute	15–29	...	...	.....	.....	.....	.....	.....	.....	.....	....	....	.....	.....	.....
	30–39	4	2	.....	.....	1	.....	2	.....	.....	....	....	.....	.....	.....
	40–49	3	5	.....	.....	2	.....	1	3	.....	....	....	.....	.....	.....
	50–59	6	7	3	1	.....	2	2	1	.....	....	....	.....	.....	.....
	60–69	2	4	1	.....	1	.....	.....	2	.....	....	....	.....	1	.....
	70–79	3	2	2	.....	1	.....	1	.....	.....	....	....	.....	.....	.....
	80–89	...	...	.....	.....	.....	.....	.....	.....	.....	....	....	.....	.....	.....
	Total	18	20	6	1	5	2	6	6	.....	....	....	.....	1	.....
	Percentage	...	...	33.3%	5.0%	27.7%	10%	33.3%	30%	.....	....	.....	.....	5.5%	.....
Acute Receding	15–29	...	1	.....	1	.....	1	.....	.....	.....	....	....	.....	.....	.....
	30–39	3	3	.....	.....	1	.....	1	1	.....	....	....	.....	.....	.....
	40–49	7	4	4	.....	1	.....	4	.....	.....	....	....	.....	1	.....
	50–59	9	7	5	.....	3	.....	6	3	.....	....	....	.....	1	.....
	60–69	9	1	6	.....	1	.....	2	.....	.....	....	....	.....	.....	.....
	70–79	...	...	.....	.....	.....	.....	.....	.....	.....	....	....	.....	.....	.....
	80–89	...	1	.....	1	.....	.....	.....	1	.....	....	....	1	.....	1
	Total	28	17	15	2	6	1	13	5	.....	....	....	1	2	1
	Percentage	...	...	53.5%	11.8%	27.7%	5.9%	46.4%	2.9%	.....	....	.....	5.8%	7.1%	5.8%
Normal and Chronic	15–29	14	4	4	.....	1	1	3	.....	1	.....	....	.....	.....	.....
	30–39	28	14	8	.....	5	1	8	1	.....	....	1	.....	.....	.....
	40–49	52	16	10	.....	16	1	11	3	.....	....	....	.....	.....	.....
	50–59	48	29	19	.....	16	4	18	1	1	....	....	.....	.....	.....
	60–69	33	8	12	.....	12	3	12	1	.....	....	....	.....	2	.....
	70–79	5	2	1	.....	2	.....	2	.....	.....	....	.....	.....	.....	.....
	80–89	...	...	.....	.....	.....	.....	.....	.....	.....	....	....	.....	.....	.....
	Total	180	73	54	.....	52	10	54	6	2	....	1	.....	2	.....
	Percentage	...	...	30.0%	.....	21.4%	13.6%	30.0%	8.2%	1.1%	....	.5%	.....	1.1%	.....
	Grand Totals	226	110	75	3	63	13	73	17	2	....	1	1	5	1
	Percentage	...	...	33.1%	2.7%	28.8%	11.7%	32.3%	15.4%	0.9%	....	.4%	.9%	2.2%	.9%

prostigmine, pitressin or stigminine were used and the application of stupes, multiple enemas, excessive use of the tidal wave or laxatives were necessary for relief. This again presents a substantial decrease in the irradiated group in excessive abdominal distention.

TABLE III
COMPARISON OF PENICILLIN DOSAGE IN BILIARY SURGERY IN NON-IRRADIATED AND IRRADIATED PATIENTS*

Penicillin (Units)	Non-irradiated Patients Total 226		Irradiated Patients Total 110	
	No. of Patients	Total Patients (Per Cent)	No. of Patients	Total Patients (Per Cent)
1,000,000 to 2,000,000	24	10.6	13	10.9
2,000,000 to 3,000,000	26	11.5	2	1.8
3,000,000 to 4,000,000	11	5.3	1	0.9
4,000,000 to 5,000,000	4	2.0	0	0
5,000,000 to 6,000,000	2	1.0	0	0
up to 18,000,000	3	1.5	0	0
Grand totals	2	1.0	2	1.8
	72	31.8	18	15.4

* Patients in whom 1,000,000 or more units were used.

Excessive temperature elevations above 102°F. were present in 32.3 per cent of the non-irradiated group. In many cases this was present in spite of antibiotic therapy. In the irradiated group 15.4 per cent presented temperatures above 102°F. This again presents a decrease of excessive temperature elevation in the irradiated group.

Thrombophlebitis and phlebothrombosis were diagnosed and classified only on the presentation of definite clinical evidence of these complications. There were 0.9 per cent in the non-irradiated group and none in the irradiated group. One case of left iliac thrombophlebitis in an eighty-seven year old female patient, which was present several weeks before hospitalization was not included in this series as a postoperative complication but was included in the mortality statistics following the development of fatal pulmonary embolus after the patient had fully recovered from operation.

Pulmonary infarction occurred in 0.4 per cent of the non-irradiated group as compared to 0.9 per cent in the irradiated group. This was based on definite clinical and x-ray diagnoses.

There was 2.2 per cent mortality in the non-irradiated group and 0.9 per cent in the irradiated group. The only death in the irradiated series was that of an eighty-seven year old female with thrombophlebitis of the left iliac vein present for several weeks prior to hospitalization. (Table III.)

Table III lists separately the cases in which penicillin was used. It is apparent that not only was penicillin used much less frequently but also in smaller amounts in the irradiated group. It will be noted in Table III that two irradiated patients received in excess of 6,000,000 units of penicillin. Mrs. K., age fifty-three, was given 16,800,000 units of penicillin by her family physician in treatment of an acute receding cholecystitis with choledocholithiasis before she was referred for surgery. No penicillin was used after the operation. Miss O., age forty-nine, was given 12,100,000 units of penicillin and 13 gm. of streptomycin beginning on the fifteenth postoperative day. This was ordered by her family physician for an Escherichia coli infection of the urinary tract.

SUMMARY

1. The use of UBI is a valuable adjunct in biliary surgery when used preoperatively and postoperatively.

2. The need for gastric suction to control nausea and vomiting is greatly lessened and, therefore, decreases loss of electrolytes.

3. Abdominal distention is remarkably decreased.

4. The need for antibiotic therapy is greatly minimized.

5. The complications of phlebothrombosis and thrombophlebitis are decreased.

6. Mortality is decreased.

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Often patients with gastric polypi have rather indefinite gastric symptoms that defy diagnosis; x-ray studies may even be entirely negative. Such patients with persistent symptoms ought to be gastroscoped. Occasionally one finds multiple polypi or one or more polypoid growths that grossly appear benign. Some of them, however, have been proved to harbor malignant foci. The moral seems to be that instead of adopting a waiting attitude one should advise prompt operation and remove the growths through a gastrotomy incision if feasible; otherwise a gastrectomy is needed. (*Richard A. Leonardo, M.D.*)

EFFECT OF DICUMAROL ON WOUND HEALING*

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AN experimental attempt is made to investigate the effect of dicumarol® on wound healing. The method of direct observation and histologic study is used in wounds made in dogs. Under the experimental range (prothrombin of 10 per cent or less) there is a definite tendency to bleed into the wound. Besides this, no difference between control and experimental wounds could be detected. Wounds under the influence of dicumarol® healed as rapidly as those made under similar circumstances without this drug. These findings are in keeping with clinical experience. Various methods used in wound-healing study are briefly outlined. Some of the faults and shortcomings of each are indicated. Particular attention is leveled at the procedure which bursts a previously sutured hollow viscus or body cavity by inside pressure. It is pointed out that stress on such a wound is proportional to the diameter of the cavity as well as to the pressure in that cavity. Much of the work on wound strength has been done by this method without any consideration of the organ size or diameter.

* * * *

The continued use of dicumarol® in surgical patients suggests the advisability of inquiring into the effect of this drug on wound healing. Numerous studies have been made in regard to heparin and wound healing. Two of these[1,2] include as a portion of that study a brief inquiry and comment on dicumarol.® No other references to the subject could be found.

Part of Sandblom's[1] extensive review on the subject of wound healing deals with the effect of dicumarol® on healing skin wounds in rabbits. He experienced considerable difficulty in obtaining uniform prothrombin blood levels. There is also reason to doubt that the prothrombin remained at therapeutic levels throughout the five-day test. The resulting breaking strengths (tensiometer) were quite variable but no significant differences were noted as compared with the control animals. Bendix and Necheles[2] using dogs also had difficulty in the control of prothrombin levels. Their experiences with dicumarol® were too brief for conclusions. They warn of the systemic dangers of this drug as compared with heparin.

In a broad sense the effect of dicumarol® on wounds is already well understood. It is known that wounds heal very satisfactorily in patients receiving a therapeutic quantity of the drug. A critical survey on an experimental basis has been of value to us and should be of interest to others.

METHODS

Seventeen mongrel dogs varying in weight from 19 to 52 pounds were used. One of these dogs was used once as an experimental and again later as a control animal, thus making a total of eighteen dogs used. Of these, eleven were given dicumarol® and seven were used as controls.

Each dog was given a daily diet of Purina Dog Chow supplemented by standard canned dog food with water as desired. Vitamin C deficiency as a factor in wound healing was eliminated by giving each animal a daily dose of 100 mg. of ascorbic acid (cecon).

Each experimental dog was given 50 mg. of dicumarol® as an initial dose and from 25 to 50 mg. of dicumarol® either daily or every other day depending on the prothrombin time. Prothrombin times were determined daily or every second day throughout the course of the experimental work. All these animals were maintained at a prothrombin level of 10 per cent or less.

Prothrombin times were determined as follows: 4½ cc. of whole blood were drawn into a test tube containing ½ cc. of .1 molar sodium oxalate. The test was run within two hours after the blood was drawn and usually within one hour.

To .1 cc. of the aforementioned plasma was added .1 cc. of thromboplastin derived from

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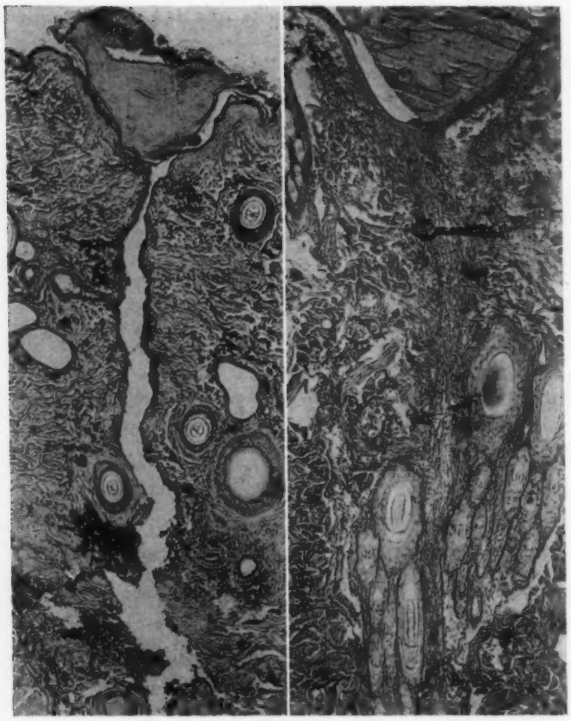

FIG. 1. Four-day wound healing control on left; experimental skin wound under influence of dicumarol® on right. Artifact of the control wound gives appearance of non-healing. There is somewhat more maturity in this particular experimental wound. (van Gieson's stain.)

placental extract.* The mixture was incubated at 37.5°C. for one minute in a water bath following which .1 cc. of .025 molar calcium chloride at the same temperature was added. The tube containing these ingredients was removed from the water bath and tilted regularly every three to four seconds from the vertical to the horizontal and back until a clot formed. A stop watch was used for timing and was started on the addition of the calcium chloride and stopped with the formation of a clot.

All of the experimental dogs had at least one and most had two prothrombin titrations each of plasma dilutions of 50, 30, 20 and 10 per cent. Using these values a hyperbolic curve was drawn in which the ordinates represented per cent and the abscissas represented prothrombin time in seconds. Experimental work was started only after the animal had reached and was maintained at a prothrombin level of 10 per cent or less.

*This preparation has been used in the Indiana University Hospitals with valid and rather constant results.

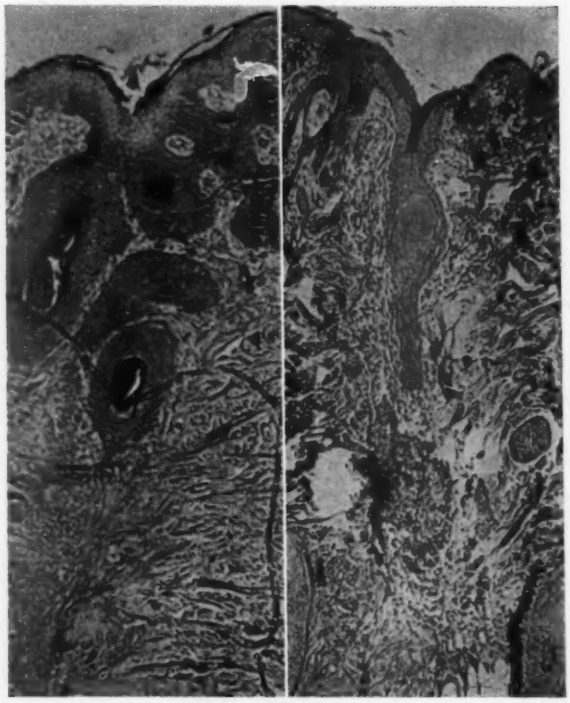

FIG. 2. Nine-day wound healing control on left (hematoxylin-eosin stain); ideal dicumarol® wound healing on right (trichrome stain).

In the first six dogs incisions were made through skin, fascia and muscle of the abdominal wall. This site was discontinued because of the frequency of wound infections and because incisions through fascia and muscle added variables which seemed unnecessary.

For the most part skin incisions were made over the dogs' shoulder so that the animal could neither lick nor scratch them. At the start of the experiment three ½-inch incisions were made at this site so that one could be excised on the fourth, sixth and ninth postoperative day. Each incision was closed with a single silk mattress-on-edge suture.

The excised wounds were fixed in Zenker's solution and stained with hematoxylin-eosin, van Gieson's and trichrome stain.

RESULTS

Grossly, there was no difference in the appearance of the experimental and control wounds except for one feature. There was a definite tendency on the part of the experimental wounds to bleed. The result was that if the ooze was not entirely stopped, a hematoma would develop. This, of course, would definitely weaken the wound and delay healing. Sandblom[1] noted the same bleeding tendency.

When this was controlled in the experimental wound, we were unable to detect any detrimental effect of dicumarol® on healing rate or production of any of the elements necessary to wound healing.

Forty-seven wounds were excised at various intervals of healing (four, six and nine days) and studied histologically. Twenty were from control animals and twenty-seven from experimental. No attempt was made to estimate or tabulate the amount of collagen or reticulum found in the sections as others[12] have done. The photomicrographs shown in Figures 1 and 2 are representative and typical of the series. With the three stains used no real difference was noted between the control and experimental wounds. For wounds of the same age the amount of recticulum, collagen and the number of fibrocytes seemed to be identical.

COMMENTS

This method of studying wound healing may seem intangible and open to question. However, so are other methods. For this reason a brief discussion of the problem seems indicated.

There are in general three different types of procedures which have been used in the study of experimental wound healing. They are the following:

Perhaps the most popular means of comparing wound healing and wound strength has been that used by Harvey and Howes[3] and others.[4–8] This consists of making an incision in the abdominal wall or the stomach or other hollow viscus of an experimental animal. The wound is then sutured under the conditions of the experiment. Healing progresses to the termination of the tests at which time water or air is injected into the hollow viscus or abdominal cavity until the wound or organ ruptures.

On the surface this would seem to be a very exact means of comparing wound healing and wound strength. Perhaps it is the most trustworthy method but it is not faultless.

First of all it has been assumed by all the workers using this method that the manometer reading at which the sutured wound ruptures can be directly translated into the tensile strength of that wound. This is false and quite misleading since an added factor is the particular diameter of the viscus in question. In other words with equal pressures the tension on a sutured wound varies directly with the diameter of the viscus and is not wholly dependent on the manometer reading. Wound tension is only indirectly related to the cross sectional area of the hollow viscus as suggested by Price.[9]

There is nothing mysterious about figuring the tensile stress on the wall of any tank or bladder-like structure. It is a common engineering computation.[10,11] It is equal to the unit pressure times the projected area (diameter) over which that pressure acts divided by two (two sides). Since the viscus is circular, the diameter is usually given as radius (diameter divided by two). Thus $S = pr$ when S is the tensile stress, p is the unit pressure and r is the radius.

The significance of this may not be clear until we examine an actual case. Let us say we have incised and sutured wounds in the stomachs of rabbits A and B. After a week the animals are anesthetized, their stomachs tied at both ends and connected to a manometer. Both ruptured at the suture line as the pressure reached 100 mm. Hg. In the past it was argued and reported that both wounds had the same tensile strength without considering the size of the particular viscus.

In our example let us say that stomach A was 2 cm. in diameter at its incised area when it burst and stomach B measured 4 cm. Then using our formula ($S = pr$) it is found that although the internal pressure (p) was the same, the tensile strength (S), withstood by wound B was two times that of A since r was twice as great. By the same reasoning wound B was twice as strong although the pressure which broke both wounds was the same.

This is applicable only to the freely distended viscus or abdominal wall which is blown open by an equally distributed gas (or liquid). It is a law of physics and must not be confused with experimental results.

Other objections to this method of wound-healing study are those which cannot be eliminated in any such study. There is a large human factor of different operators and the same operator under different times and circumstances. It is likewise not valid to compare the strength of wounds sutured with absorbable and non-absorbable material. The non-absorbable material obviously may add to the tested strength of the wound and, therefore, not give a true reflection of the situation at hand.

Catgut in itself may be the uncontrolled

factor through its variation in absorption time or reaction in the tissues. There is also the variation in response or sensitivity of the individual (or animal) to the catgut.

The second method of testing wound-healing strength is actually to find out how much force is required to pull a given wound apart. Several types of tensiometers have been used to measure this force. One variation consists of testing strips of tissue supposedly of equal width through like portions of the wound.[12] The variables of such tests are obviously many. This is especially true when considering the added factors of interrupted or continuous suture, just where in relation to the sutures the particular tissue was taken, the method of fixing tissue to the tensiometer and the variable shearing action of this instrument on the wound.

To these objections may be added many of those mentioned in the first method.

The third method of wound-healing study consists of (1) directly observing and measuring of the healing of various skin defects[13] or (2) histologic study of various stages of healing wounds. The first type of study is, of course, limited to wounds healing by secondary intention.

In the method of study by histologic section we have no concrete knowledge of just how strong the wound may be. We have only histologic evidence which we compare to a similar wound in a cortrol animal. This may be quite convincing but nevertheless the results are a picture and not a measure in pounds strength per linear inch of healing wound.

When evaluating such a wound various features are taken into consideration. The wound may be graded as to content of reticulum, collagen, fibrin, hemorrhage and fibrocytes. These are all important features for consideration in any healing wound but they do not necessarily indicate whether or not ideal healing has occurred. For instance it has been inferred that the greater the production of reticulum and collagen the stronger has been wound healing.[12] This may be so but in our experience infected wounds produced excessive amounts of collagen and reticulum. These excesses are far from the ideal goal for wound healing. In fact the most ideal primary healing occurred when these substances were at a minimum and were represented histologically by only a thin line.

We have used this method to study wound healing under the influence of dicumarol.® The faults and shortcomings of the method are fully admitted. In the same breath we emphasize the faults of other methods.

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ACUTE ACETONE POISONING FROM CASTEX

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CASTEX contains acetone. Acetone is capable of producing acute intoxication which is characterized by severe nausea, hematemesis, dysuria, tachycardia, depression, acetonuria and glycosuria.

* * * *

In 1938 Peterson[1] endorsed the useful material known as castex. Three cases of acute acetone poisoning have since been described in the literature[2–4] without naming the offending agent although the chemical components of the "synthetic cast material" used in each case were so named. This no doubt gracefully spares the reputable manufacturer or manufacturers but would it not be more concise and clinically useful to designate the noxious substances by their usual clinical titles?

To prove that this communication is constructive in intent we hasten to say that we have been using castex since 1939 and do not intend to abandon it because of this one unhappy experience. However, more caution will be exercised in the future regarding the quantity used and the ventilation of the undried cast. Also, some impervious material will be placed between patient and cast hereafter—cellophane or polythene—as the skin absorption of acetone is still in question. In the case of body casts it seems advisable when possible to form the material, split on one side, remove it from the patient for drying and lacquering, then replace twenty-four to forty-eight hours later. Three of the four reported poisonings (including this one) resulted from variation of truncal casts; the fourth was a double leg cast. This suggests the possibility that the large areas of skin exposed to the fat-solvent agent may have produced significant percutaneous absorption. To support this possibility in the case described by Strong[2] one would judge that adequate precaution was used regarding ventilation.

The factor of varying susceptibility is not to be overlooked. Two bedridden patients with Pott's disease who were half enveloped in castex are brought to mind and a third, an arthritic with double leg casts showed no obvious signs of acetone poisoning.

CASE REPORT

Mrs. I. K. age thirty-two sustained injury in May, 1949, when she fell over a market basket. She suffered numerous lacerations and contusions. In June she noticed lower abdominal cramping and obstinate constipation. These were previously unheard of symptoms but we largely discounted them for lack of objective signs. In September she also complained of a "crick" in the lower back and weakness of the left quadriceps. At this time there was measurable atrophy of the left lower extremity and the patient was hospitalized for myelogram. During this hospitalization her urine, blood and serologic tests for syphilis were normal; and although the myelogram showed only slight displacement of the medium, the consulting neurologist confirmed the tentative opinion of a prolapsed fifth intervertebral disc.

On October 25, as an outpatient, a castex corset was applied over stockinette and a thin layer of sheet wadding. Since the patient was moderately obese (height 63 inches, weight 156 pounds) and normally very active, twelve 4-inch rolls were thought necessary for appropriate strength. The day was cool so the windows of the 8 by 10 foot cast room remained closed until the patient, operator and technician noted that the odor of acetone was of intolerable concentration. The patient was covered with a blanket, two large windows were opened and an electric wall fan was used to create general convection, with relief of all concerned. When the corset had set, the patient was allowed to dress and depart—about 6 P.M. The patient was outdoors for two hours, had dinner at home and went to a movie. Here she noticed increasing headache but viewed the two and a half hours' performance. She went home to sleep in a room with two open windows. Prior to retiring at 11 P.M. she noticed slight nausea, notwithstanding which she drank coffee. She soon vomited. She "slept more soundly than she had in months" but was easily aroused at 7:30 A.M. Severe nausea and burning pain on urination ensued. She was weak and dizzy.

When seen in the office at 10 A.M. she appeared pale, weak, excited and dysarthric. She complained of tenesmus. Her blood pressure was essentially unchanged but her pulse was 120/minute and her breath reeked of acetone. She was hospitalized and admission urinalysis showed the following: acid, specific gravity 1.018, sugar 3 plus, acetone 2 plus, occasional pus and epithelial cells. Complete blood count revealed the following: erythrocytes 4.46 million, hemoglobin 12.5 gm., white blood count 6,250, stabs 5, total neutrophiles 92, total lymphs 8 and coagulation time three minutes. An intravenous infusion of 5 per cent glucose in normal saline solution and a saline enema were given. The tenesmus and headache increased and the patient was moderately somnolent, partly due to the codeine (1 gr. doses) required for pain. At 2:30 A.M. another infusion of 5 per cent glucose was given, this time in distilled water. The patient was aroused for the beginning and slept through administration of most of the infusion. A urine specimen taken at this time showed acetone 2 plus. At 8 A.M. the patient had no physical complaints but continued to be emotionally upset. She related this to the residual odor of acetone. A fasting blood sugar at this time revealed 97 mg. per cent. The patient appeared to be relieved of the intoxication and was discharged at 10 A.M.

In the office urinalysis on October 31st showed specific gravity 1.020, acid, faint trace of albumin, no acetone or sugar. On November 3rd the hemogram was normal. There appeared to be no residual signs referable to the poisoning.

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Case Reports

LEIOMYOSARCOMA OF THE DUODENUM

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THE duodenum is rarely the seat of benign or malignant tumors. Although carcinoma of this region comprises about 5 per cent of the total intestinal carcinomas, occasionally malignant tumors of the smooth muscle are encountered. Leiomyosarcoma follows a rather slow, progressive, malignant clinical course; hence these lesions offer a splendid opportunity for surgical eradication. A review of the literature shows that only sixteen cases have een reported[1–14] including the author's case.*

A study of the cases of this rare lesion reported during the last ten years would suggest that it is being diagnosed with greater accuracy and that the surgical management has greatly improved. A preponderance of cases occurs from the fourth to sixth decades of life and is more apt to affect the male than the female in the ratio of 3:2. It has been suggested by Boyce and McFetridge[15] that trauma might be an etiologic factor.

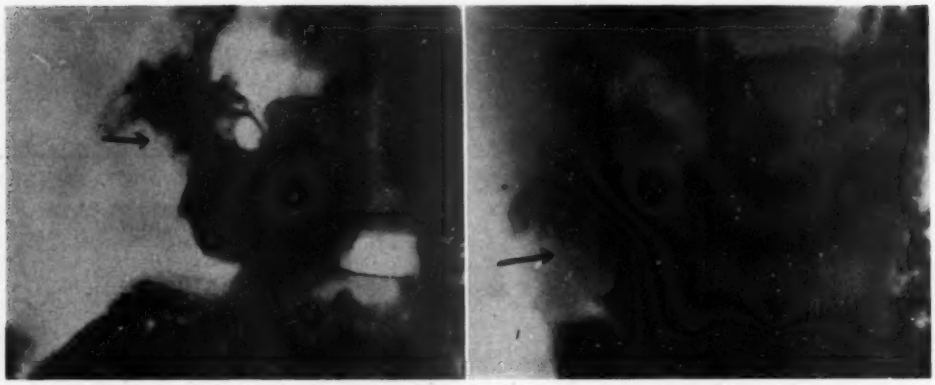
The symptoms of leiomyosarcoma of the duodenum resemble in a general way those of sarcoma of any other part of the small intestine. They are chiefly pain, loss of weight, weakness and anemia. If the growth arises from the outer muscular layer, the tumor may become very large and may be palpated early. If it arises from the inner coat, there is usually early bleeding into the intestinal tract. Diarrhea does not usually occur with sarcoma of the duodenum unless it involves the ampulla of Vater; then it has the characteristics of disturbed pancreatic secretions. The diarrhea of intestinal sarcoma elsewhere than in the duodenum is due to irritation and hypermotility of the bowel and does not show evidence of pancreatic dysfunction. Intrinsic growths of the duodenum obstruct sufficiently to cause pain, but never intussusception because they are fixed. High fever, jaundice and other symptoms are reported; however, these are not common. Perforation has been reported in two cases.

The exact nature of this lesion cannot be determined until the abdomen is opened. A large growth palpated in the right upper quadrant should arouse suspicion. During the last few years considerable emphasis has been placed on the diagnosis of lesions of the small intestine by means of x-ray. Feldman,[16] Weintraub and Tuggle[17] and others have emphasized this point. Positive x-ray findings plus the symptoms previously enumerated suggest a provisional diagnosis.

Pathologists differ as to the origin of these tumors. It was suggested by Conheim[18] that they develop from embryonal cell rests. Obendorfer[19] believes that they may arise from benign leimyomas, while Ewing[20] states, "It is not to be assumed without adequate proof that a malignant myoma represents the transformation of a previous benign tumor. Many and probably all these tumors are malignant from the first." They tend to remain localized longer than other types of sarcoma of the bowel. The major part of them are subserous and may grow very large. The smaller submucous growths cannot grow very large before they produce symptoms requiring intervention. A few have been reported as pedunculated. Even the more frequent sessile type is not invasive. These growths are pale, nodular, rather firm and tend to ulcerate early. The microscopic picture appears in the pathologic description of the case reported hereafter.

The treatment is surgical. When discovered early some of the growths may be excised lo-

* It is possible that other cases have been reported between 1944 and 1947, but the available literature did not reveal any. Harrington's case reported in 1940 was operated in 1938. Later in 1940 C. W. Mayo reported all the cases of duodenal malignancy on record at the Mayo Clinic. Two of these were leiomyosarcoma, and it is assumed that he reported the case listed above by Harrington, but not counted in this report.



1 2

FIG. 1. Anteroposterior view; arrow is pointing into defect caused by tumor.
FIG. 2. Oblique view; arrow is pointing into defect caused by tumor.

cally, but any surgeon approaching them should be thoroughly familiar with and capable of performing a pancreaticoduodenal resection. The operation perfected by Whipple and Parsons[21] or some modification thereof is the operation of choice. Every attempt should be made to preserve the external secretions of the pancreas.

CASE REPORT

B. B. (No. 8785), a white, married female aged forty-two, was admitted to the Wichita General Hospital on December 28, 1947, because of gradual weakness and failing strength. She stated that she had recently lost 4 pounds in weight. She had no pain or indigestion but had recently noted tarry stools. Her mother died from pellagra and her father from "throat trouble." Five brothers and two sisters were living and well. There was no familial history of cancer or tuberculosis.

Two years before the patient was admitted to the Wichita General Hospital by one of the authors (G. G. C.), with a history of loss of strength and indigestion. She complained of mild epigastric pain which was relieved by soda and the ingestion of food. At that time she had tarry stools. Gastrointestinal x-ray films were suggestive of a gastric ulcer on the lesser curvature just above the pyloric sphincter. The duodenum and the remainder of the intestinal tract were reported as normal. Her blood count was 2,400,000 red blood cells with 45 per cent hemoglobin, and 10,000 white blood cells with 78 per cent polymorphonuclears and 22 per cent lymphocytes. She remained in the hospital eight days and was given a diet and four blood transfusion of 500 cc. each. On discharge the red blood count was 4,450,000 with 80 per cent hemoglobin, and the white blood count was 7,200 with 73 per cent polymorphonuclears and 27 per cent lymphocytes. The urine was normal. She did fairly well until December, 1947, when she returned with the symptoms already related.

Physical examination revealed a bright but pale and underweight female 62 inches in height. Her normal weight was 105 pounds but her present weight was 101 pounds. Her temperature was 98.2°F. and blood pressure 104/76. Examination of the head, neck, heart and lungs revealed nothing abnormal. Her abdomen was flat and there was no tenderness. To the right of the midline about 2 inches below the gallbladder a movable, elongated tumor was palpable. It was about 5 cm. long and 2 cm. in diameter. Her liver was not palpable. The remainder of the physical examination was negative.

Red blood count was 3,280,000, hemoglobin 7.5 gm., white blood count 5,700, 69 per cent polymorphonuclears, 26 per cent lymphocytes, 2 per cent eosinophiles and 3 per cent monocytes. The urine was normal but the stools contained occult blood.

The roentgenologic report revealed that the chest and heart appeared normal with the exception of a tenting of the left diaphragm due to adhesions. The esophagus, stomach and duodenal bulb appeared normal. There was, however, a marked irregularity in the second part of the duodenum. The mucosa was definitely disturbed. The duodenal wall appeared fixed and there was a ragged filling defect involving about 2 inches of the descending duodenum. (Figs. 1 and 2.) These changes were strongly suspicious of a malignant neoplasm of the duodenum despite the fact that such a condition is quite rare.

A severe inflammatory process might produce the changes described. There was no obstruction. Further study of the colon revealed nothing significant.

Preoperatively, the patient was kept under observation for ten days. She received two blood transfusions of 500 cc. each. Exploratory operation was advised.

On January 8, 1948, under pentothal® and cyclopropane anesthesia (with curare) the abdomen was opened through a long right paramedian incision. Exploration revealed a normal liver, spleen, pancreas, kidneys, colon and pelvic organs. On the anterior surface of the duodenal bulb there was a peritoneal scar suggesting previous ulcer. No enlarged nodes were found. The second part of the duodenum revealed a growth about 5 cm. long and about 2½ cm. in diameter. It extended from about 1 cm. below the ampulla downward. An attempt was made to mobilize the duodenum, excise the growth and perform an end-to-end anastomosis; however, because of its proximity to the ampulla a pancreaticoduodenal resection was selected. The duodenum and head of the pancreas were easily mobilized, but in the process of mobilizing a rather large uncinate process of the pancreas, the superior mesenteric vein was torn. It was closed with fine silk sutures without difficulty. The common bile duct was small and difficult to mobilize. It was cut and doubly ligated with silk. The duodenum was then severed just proximal to its disappearance beneath the mesenteric vessels, and the lower end closed with two rows of No. 00 chromic sutures reinforced with tags of fat. The pancreas was severed through its neck, and the parenchyma closed up to its duct with fine silk sutures. The stomach was then amputated just proximal to the pyloric sphincter. A loop of jejunum was brought out and an entero-anastomosis done with two rows of No. 00 chromic sutures. The stomach was anastomosed to this loop (end-to-side) with two rows of No. 00 chromic catgut. Just above this the neck of the pancreas was anastomosed (end-to-side) with fine interrupted silk; the gallbladder was anastomosed to the proximal part of the loop with two rows of No. 00 chromic sutures. (Fig. 3.)

The wound was closed in layers with No. 0 chromic catgut, four tension sutures and dermal sutures. A rubber tissue drain was brought out through a stab wound. The operation lasted three and a half hours. The patient was given

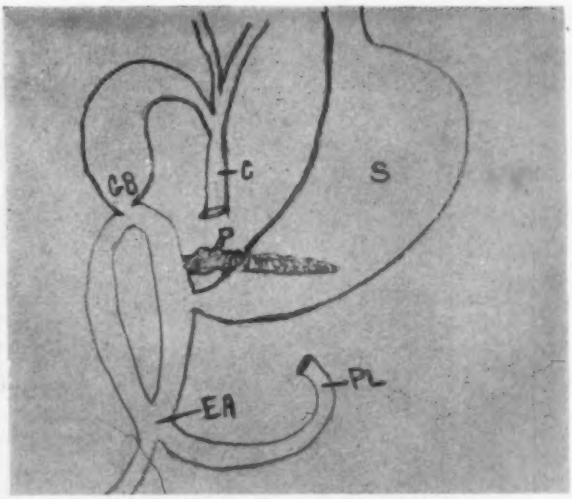
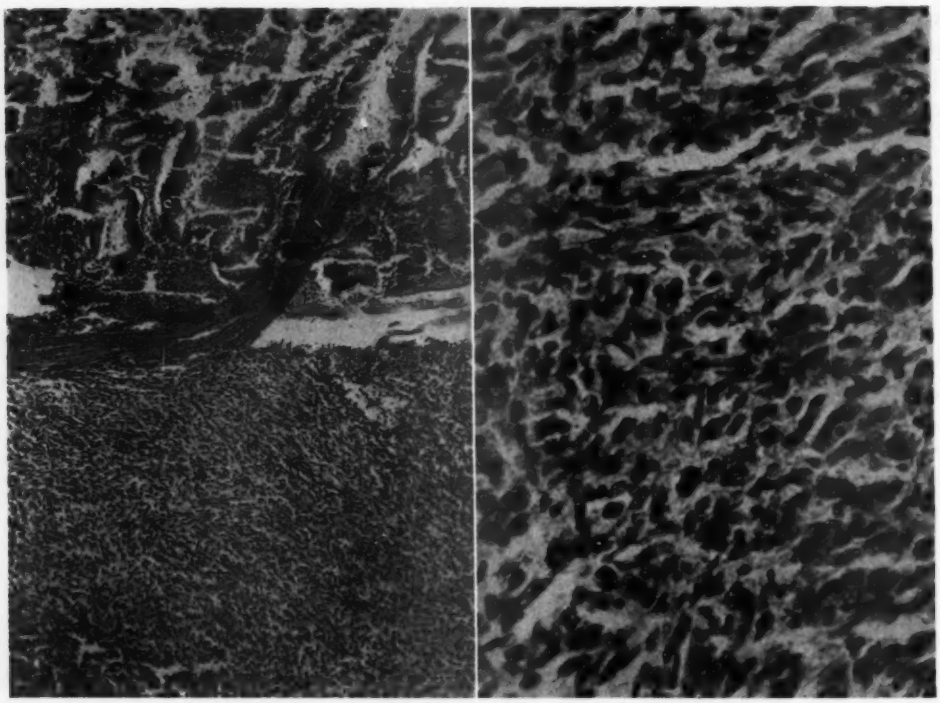


FIG. 3. Diagram of technical procedure; GB, gallbladder; C, common duct; S, stomach; P, pancreas; EA, enteroanastomosis; PL, proximal loop of jejunum and third portion of duodenum.

1,500 cc. of blood during the course of the operation; at the close her pulse was 104 and blood pressure 120/70.

The pathologic report revealed the following: Grossly, the specimen consisted of 13 cm. of duodenum, the major portion of which was largely replaced by a roughly ovoid, cauliflower-like, ulcerated tumor. The ulcerated surface was hemorrhagic and necrotic. The bordering mucous membrane was thickened and rolled but could easily be peeled from the growth. The papilla of Vater was not demonstrable. On section the tumor presented a more or less diffusely uniform, fleshy and somewhat granular appearance. The growth was of rubbery consistency and appeared to merge with the muscularis of the intestine. The serosa was smooth and vascularized but apparently not infiltrated by the lesion. Another small segment of intestine attached to a piece of pancreas 3 by 4 by 5 cm. in diameter was present. In this specimen the ampulla of Vater was identified. Microscopically, the surface of the specimen showed extensive granulating ulceration and a wide zone of hemorrhagic necrosis. The neoplasm presented a diffusely and highly cellular structure of elongated and fusiform cells. In areas the cells were regularly placed and resembled smooth muscle. Elsewhere the cells were chaotically disposed and their processes interlaced indifferently. The nuclei varied from elongated rods to roughly ovoid in shape. The nuclei also showed considerable variation in hyperchromatism. In the



4 5

FIG. 4. Leiomyosarcoma merging with muscularis mucosa. × 100.
FIG. 5. Higher magnification of neoplasm showing mitotic figures. × 560.

chaotic areas hyperchromatism was marked, anisonucleosis was present and occasional mitotic figures occurred. At the borders of the tumor the neoplastic cells merged inseparably with the muscularis of the bowel wall. (Figs. 4 and 5.) The diagnosis was leiomyosarcoma, grade 2.

Postoperatively, nothing was given by mouth for ninety-six hours. Wangensteen suction was instituted. During the first ninety-six hours the patient was given two blood transfusions of 250 cc. each and was given 1L. of 5 per cent glucose every eight hours (one of these with saline each twenty-four hours). On the second day the drain was removed and profuse watery drainage followed. This ceased entirely after a few hours, however. The patient's condition remained good at all times, her maximum temperature being 100.6°F. and the maximum pulse rate 110. On two occasions following administration of glucose she went into mild hypoglycemic shock, evidenced by profuse sweating. This ceased when amigen was substituted for glucose and given very slowly. After suction was discontinued the patient was placed on small amounts of liquid nourishment. This was rapidly replaced by solid food. On the eighteenth postoperative day her red blood count was 5,460,000 with hemoglobin 14.5 gm. The blood sugar was 117 mg. per cent. She left the hospital on the nineteenth postoperative day after being up and about for almost one week.

The patient progressed nicely for about six months. She then showed evidence of liver metastasis in the left lobe. The upper part of the abdomen rapidly filled with the growth and the patient expired on May 15, 1949, a little over sixteen months after the operation. No autopsy was obtained.

CONCLUSIONS

Leiomyosarcoma is a rare lesion of the duodenum, only sixteen cases having been reported including the present one. It is amenable to successful surgical management, particularly when it grows into the lumen, because the symptoms and x-ray findings are such that it can be diagnosed reasonably early. It can be removed locally when properly situated or by pancreaticoduodenal resection when the ampulla is involved. The patient's nutritional state can be maintained at a higher level if the external secretions of the pancreas are preserved.

Acknowledgment: We wish to thank Dr. Joseph G. Pasternack for his helpful suggestions in the preparation of this paper and for his as-

sistance in preparing the photomicrographs, and Miss Lou LeBus for her aid in assembling the material.

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LUMBAR SPINAL EXTRADURAL CYST

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SINCE the report in 1934 of Elsberg, Dyke and Brewer[1] until November, 1946, there have been twenty-two reports of lumbar spinal extradural cyst. One of these was in the cervical region, nineteen were in the dorsal region and two, although primarily in the dorsal region, extended into the upper lumbar region. As pointed out by Cloward and Bucy,[2] practically all of the reported cases were associated with Scheuermann's disease[3] (kyphosis dorsalis juvenilis).

FIG. 1. Showing an x-ray of the dorsal spine revealing no evidence of kyphosis dorsalis juvenilis.

The case reported by us is apparently unique in that the cyst was located entirely in the lumbar region and was not associated with Scheuermann's disease. (Fig. 1.)

CASE REPORT

M. H., a twenty-seven year old salesman, was first seen in November, 1945. This man had noticed low back pain and pain in his left hip and leg two and a half years previously while in active service in the army. He had also noted paresthesia of the outer left thigh but had no other complaints and had worked steadily although never free from discomfort in the left leg.

Examination showed some stiffening of the lumbar muscles on bending forward, slight hypesthesia of both little toes and an area of hypesthesia over the left lateral thigh. The deep reflexes were normal at the knees and ankles. X-rays of the lumbar spine were reported as normal although on reviewing these films later it was evident that erosion of the second lumbar pedicle and vertebra on the right had been overlooked. A low lumbar disc rupture was suspected and the patient was referred to an orthopedic surgeon for conservative therapy. Manipulation under anesthesia and a cast for thirteen weeks failed to relieve the back and left leg pain, but the patient never stopped working.

When examined again in May, 1946, the lumbar muscles were quite tense and there was a list to the left on forward bending. A small area of hypesthesia over the lateral side of the left thigh was found but otherwise the neurologic examination was entirely negative.

Pantopaque spinograms (Fig. 2) were done and were reported as follows: "A spinogram was done. At the fluoroscope we saw nothing definitely abnormal in the lower part of the neural sac. However, in the upper lumbar spine we did notice slight deviation of the neural sac to the left, behind the intervertebral space, between the second and third lumbar vertebrae. This was persistent deviation; some of the pantopaque was caused to flow up through the dorsal area and there was no obstruction here.

"The film showed a slight deviation of the neural sac to the left at the level described above. There is no posterior protrusion and no deformity on the anterior wall of the neural sac revealed by the lateral projection.

"These films do reveal a very definite abnormality in the right side of the second lumbar vertebral body. The pedicle is very definitely

FIG. 2. Showing a slight deviation of the neural sac to the left behind the intervertebral space between the second and third lumbar vertebrae.

narrowed and the upper part of the intervertebral foramen is seen to encroach on this right pedicle. There is also an indentation on the right posterolateral margin of the second lumbar body. The entire appearance very definitely suggests erosion from a neurofibroma at this intervertebral foramen. This, in turn, appears to coincide with the slight deviation of the neural sac to the left at this level.

"We have reviewed previous spinal examination of January 26, 1946, and find that erosion of the pedicle on the right in the second lumbar body was present at that time.

"Conclusions: There is erosion of bone, particularly at the superior portion of the intervertebral foramen between the second and third lumbar bodies on the right which we interpret as most probably due to a neurofibroma involving the nerve root passing through this aperture. There does appear to be a slight extension into the neural canal. The major deformity, however, appears to be at the intervertebral foramen. We see no evidence of bulging of the psoas shadow at this level."

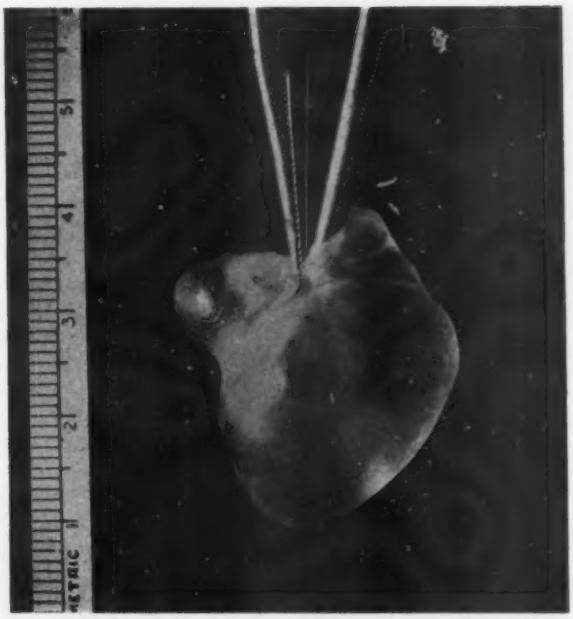

FIG. 3. Showing the sac completely removed and the entire cyst filled with fluid.

A preoperative diagnosis of extradural tumor on the right side at the second lumbar vertebra was made and on May 10, 1946, an exploration was done.

A 5-inch midline incision was made centering over the second lumbar spine. Laminectomy of the first and second lumbar laminas was performed. The yellow ligament was found increased in thickness on the right side. No extradural tumor was seen in the routine exposure. The dura was normal in color. On opening the dura the arrangement of the caudal nerves appeared to be normal. However, on retracting the nerves from the right lateral wall of the canal a soft bulging into the lateral wall outside the dura could be seen and palpated. The lamina of the second lumbar spine was then removed far laterally. It was found to be markedly thinned, and on approaching the transverse process a bluish cyst was uncovered. When this finally was completely exposed, its surface measured about 1 inch in diameter and was seen compressing the dura from the outside. At the upper end of the cyst was a ¼-inch long pedicle about ⅛ inch in diameter connecting the cyst with the subarachnoid space. An aneurysm needle was placed about this and a silk tie placed about the connecting pedicle which was then severed. Just beneath this

FIG. 4. Section of cyst wall showing loose areolar tissue covered with endothelial lining.

pedicle on the inner side of the dura was a dimple which was caudad to a nerve and vessel whose exit was just above the point of the pedicle attachment. On further dissection this proved to be an extradural cyst. The sac was completely removed. The sac itself consisted of what appeared to be arachnoid and was covered with a fibrous membrane which was easily dissected. (Fig. 3.) Fortunately the sac did not break. When removed it measured 1½ inches in diameter.

After the cyst had been removed a large cavity was left, at the base of which was a bleeding vessel which was controlled with a silk suture. The dura was closed following careful hemostasis. The wound was closed with silk to muscle, fascia, subcutaneous tissue and skin.

The patient made an uneventful postoperative recovery and returned to his former work after a few weeks. Although the backache was improved, he still was plagued by left leg pain which was controlled with aspirin. Figure 4 shows cross section of microscopic cyst wall.

When last examined in May, 1950, four years after removal of his extradural lumbar cyst, the patient still complained of slight discomfort in the left leg, but had lost no time from work.

SUMMARY

A case is reported of an extradural spinal cyst located entirely in the lumbar region and unassociated with kyphosis dorsalis juvenilis.

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POSTERIOR CERVICAL TUMOR OF BROWN FAT IN MAN

ITS RELATIONSHIP TO THE INTERSCAPULAR GLAND OF HIBERNATING ANIMALS

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A TUMOR of brown fat removed from the posterior cervical region is presented because it is probably the homologue of the hibernating or interscapular gland of certain mammals. A fairly extensive search of the literature reveals mention of only two similar tumors and Grady[1] states that he has observed others.

CASE REPORT

A male, aged twenty-one years, presented a tumor the size of an orange in the low posterior cervical region. It had been about the size of a marble when first noted in early childhood and had undergone asymptomatic enlargement since then. No other tumors were present and a roentgenogram of the chest was normal. A lipoma was diagnosed clinically and it was removed.

The specimen externally had the appearance of typical yellow adipose tissue. Section (Fig. 1), however, revealed a well encapsulated, firm, brown, lobulated tumor approximately 8.5 by 3.5 by 3.5 cm. in size surrounded by yellow adipose tissue. The tumor tissue (Fig. 2) presented a lobulated appearance with thin connective tissue septa and a rich capillary network. The cells were mainly round or polygonal fat cells, multilocular with finely vacuolated cytoplasm and round, central nuclei. In smaller numbers were typical unilocular fat cells with "washed out" cytoplasm and signet ring nuclei. A stain for iron revealed only scattered deposits of iron containing pigment. These findings were typical of brown fat and a posterior cervical tumor of brown fat was diagnosed.

BROWN FAT

Relatively little is known about brown fat. Grossly it presents an appearance somewhat different from ordinary adipose tissue. It is brown in color, everts on section and presents an appearance of irregular ribbing suggesting compact muscle. Microscopically there are typical adult fat cells in small numbers, unilocular with eccentrically placed signet ring nuclei. In great numbers, however, are smaller, rounded or polygonal, multilocular fat-filled cells, with finely vacuolated cytoplasm and moderate sized centrally placed nuclei. Afanassiew[2] believed the brown color to be due to hemoglobin containing pigment deposited in the stroma. Shattock,[3] however, observed the rich capillary network in which the fat cells were situated and believed the increased blood supply accounted for the color as well as permitted more rapid mobilization or deposition of this fat compared to ordinary adipose tissue. The rich blood supply and sparcity of pigment deposit in the tumor under consideration lend support to Shattock's theory.

HIBERNATING GLAND

Of most interest, however, is the occurrence of brown fat in the so-called hibernating gland, interscapular gland, organ of hibernation or hibernating mass. These are collections of brown fatty tissue with characteristic distribution which has been observed in fifty-five or more species of animals including the American marmot or woodchuck, the hedgehog, mole, shrew, mouse, squirrel, rabbit, guinea pig, martin, European badger, cat, dog and pig. Characteristically the distribution is in the upper mediastinum with extensions into the intermuscular septa of the neck, into the axillae and the interscapular regions. Somewhat distinct enlargements or lobes occur in the lateral neck, the axillary fossae and interscapular region, the last constituting the interscapular gland. From the thoracic mass extensions also occur caudalward along the sympathetic nerves and aorta to form masses in the perirenal areas, along the iliac vessels and in the inguinal regions. Grossly and microscopically the appearance is that of lobulated masses of brown fat surrounded by a thin

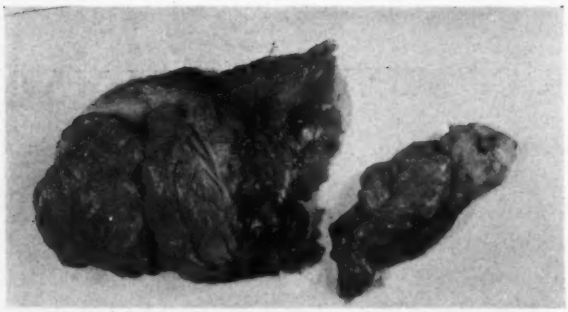

FIG. 1. Section through interscapular tumor showing central encapsulated mass of brown fat surrounded by typical adipose tissue.

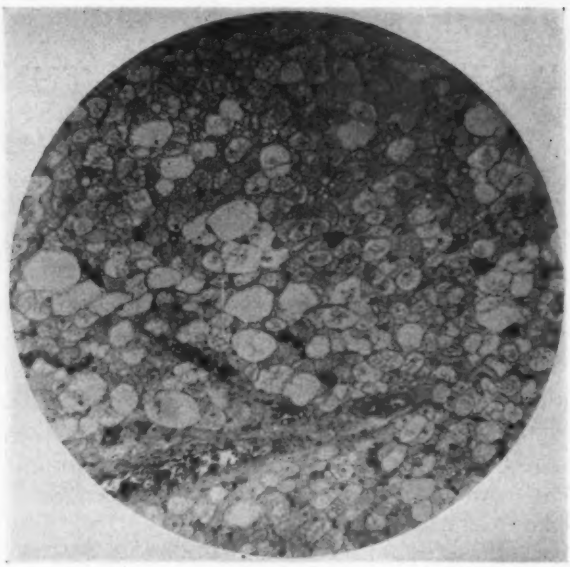

FIG. 2. Photomicrograph of section of interscapular tumor showing rich blood supply in the interlobular septa, a few unilocular fat cells with a preponderance of polygonal or round, multilocular, fat-filled cells characteristic of brown fat. × 120.

fibrous capsule. Lymph nodes may be present but are not considered an integral part of the structure.

The structures were first discussed by Velsch[4] in 1670 and have been the subject of investigation occasionally since then. Rasmussen[5] in 1923 reviewed the literature extensively and added his personal observations.

These well defined deposits of brown fat are not to be confused with characteristic deposits of fat such as the gluteal hump of the females of certain South African tribes, or with steatopygia, the fat fin of some fish, the tails of certain sheep, reptiles and rats and the hump of the dromedary or camel. Shattock[3] investigated these fat deposits extensively and found that they all consisted of ordinary yellow adipose tissue with unilocular fat cells. They have no histologic or anatomic relationship to the hibernating gland, although physiologically similar in that they also serve as reservoirs of food for use during periods of deprivation.

The origin of yellow fat remains in dispute. According to the theory of Flemming, adipose tissue arises secondarily when ordinary connective tissue cells become filled with fat. Toldt, however, believes that the fat develops primarily from definite mesenchymal cells that are round or polygonal before fat is deposited in them. There is no conclusive evidence to support either theory and some investigators believe that adult fat may develop in either manner. Assuming that it develops from specific cells, it is then possible that the polygonal fat cells present in brown fat represent some preadult stage in the development of yellow fat. Rasmussen states there is little evidence of transformation of brown fat into ordinary fat although the two types may occur together. He observed no transitional cells. Since the distribution of brown fat is practically limited to certain characteristic locations in the many species of animals in which it occurs and occasionally in man, it seems most reasonable to assume that it arises from its own specific mesenchymal cells.

Rasmussen divides the history of the hibernating gland into four periods, depending upon the then current viewpoint concerning its function. From its discovery in 1670 to 1817 it was confused with the thymus. From 1817 to 1863 it was differentiated from the thymus but classified as a ductless gland possibly of the hemopoietic series. Subsequent to 1863 it was held to be a deposit of modified fat serving as a reserve food supply during hibernation. Since 1902 it has also been considered by several investigators to be an endocrine gland.

Wendt[6] studied the effect of injections of extract of brown fat subcutaneously and intraperitoneally in white rats and found an instant fall in blood pressure and pulse rate of 20 to 30 per cent and after two to three hours, general retardation of body activity evidenced by a striking apathy. Hook[7] and Hook and Barron[8] found that intraperitoneal injection of brown fat produced lowering of the heat production and stated that its oxygen consumption is considerably higher than that of white adipose tissue and its activities are not reduced

to the same extent as that of other tissues during hibernation.

Hibernating gland tissue decreases in weight during hibernation at about the same rate as the body tissues as a whole but less rapidly than ordinary fat. This decrease is due to loss of fat rather than water or tissue destruction. Rasmussen concludes that there is insufficient evidence to classify it as a true gland and even doubts that it possesses any function during hibernation different from that of other fat deposits.

OCCURRENCE IN MAN

Reference to brown fat deposits in man in locations characteristic of hibernating glands are few. Brown fat occurs in small amounts around certain joints, particularly in the knees, and Hogue[9] mentions the occurrence of peculiar pigmented lipomas or sarcomas which arise from brown fat in these locations. Careful search in embryos and adults has often failed to reveal vestiges of this tissue, although Hatai,[10] Bonnot,[11] Shattock,[3] Berg[12] and others[14] each describe brown fat deposits in human embryos or cretins which they considered homologous to the hibernating gland. Rasmussen reviewed some of these reports but disagreed with the conclusions of most of the investigators. He believed they had presented no very convincing evidence that the tissues described were homologous to the hibernating glands.

There are two references in the literature to posterior cervical brown fat tumors similar to the present one. Two others are less definitely related. A "lipoma glandular" or posterior cervical tumor is briefly described in the annual meeting notes of the Pathological Museum.[13] The fat in this tumor had the peculiar characteristics found in the hibernating glands of animals and was believed to have arisen from a vestigial hibernating gland occasionally present in man. Complete details are not given. Inglis[14] described a similar tumor removed from the interscapular region of a male aged thirty-one years. It had been present for a year and had gradually enlarged. It was composed of deep, orange-colored tissue, quite vascular, lobulated by connective tissue septa and microscopically typical of the brown fat of the hibernating gland.

Another tumor described by Inglis was removed from a female of six weeks. It had been present in the right cervical region since birth, was semi-cystic in character and composed of three different structures, lymphatic cysts, blood cysts and cysts containing yellow fluid. In the last there were cells which resembled brown fat. Symmers[15] described a spindle and giant cell sarcoma in the precordial region of an emaciated male aged seventy-two years. Because of the presence of a few polygonal fat-filled cells resembling glandular fat he suggested that the sarcoma had originated from the primitive fat organs.

SUMMARY AND CONCLUSIONS

Because of its location, duration and histologic composition, the large tumor reported appears to be homologous to the interscapular gland of hibernating animals. It closely resembles only two other reported cases. In addition the cystic tumor described by Inglis and the sarcoma reported by Symmers may possibly have arisen from a similar anomaly. Vestiges of brown fat have been observed in the human fetus occasionally and in adults rarely in locations corresponding to the distribution of the hibernating gland in certain mammals. The brown fat of which the hibernating gland is composed differs in color from ordinary fat, probably due to increased vascularity rather than pigment deposits; it is composed largely of multilocular fat-filled cells with a few unilocular cells characteristic of ordinary fat. Its histogenesis is unknown; it may represent a re-adult stage in the development of unilocular fat cells, but most probably is a distinct type of fat arising from its own individual mesenchymal cells.

The function of the hibernating gland is not definitely known, but it is believed by some to constitute a storehouse of food for use during periods of deprivation such as hibernation; most investigators believe that it is not a true gland.

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Ileojejunitis is a chronic, inflammatory, granulomatous and cicatrizing disease of unknown etiology of the ileum and jejunum that may be patchy or diffuse in distribution. Early cases are often successfully treated with a strict medical regimen. Localized patches, not so responding, may be excised and the healthy bowel ends anastomosed. Results are good. No specific antibiotic has so far been discovered that we find of curative value in these cases; hence patients with progressive and diffuse ileojejunitis (not being surgical) have a gloomy prognosis. (*Richard A. Leonardo, M.D.*)

HYDRIODIC ACID TO OVERCOME TUBAL OCCLUSION IN STERILITY

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WHEN repeated uterotubal insufflation fails to show patency of the fallopian tubes, the outlook for the sterile patient is rather hopeless. Yet women so afflicted continue to search for help.

Presuming that the technic of tubal insufflation has been such as to rule out tubal spasm and non-adherent kinking as etiologic factors, the two most common causes of non-patency are plugs of mucus contained in the tubal lumen and inflammation with scarring and adhesions as after results. In considering what drugs might be of value in these conditions, the iodides seemed to offer some hope for success.

Among the actions usually ascribed to the iodides is the property of increasing the amount of secretion of the mucous membranes and of making the mucous secretion more watery and less tenacious. Iodides are used against thick sputum.[1] Also, iodides are supposed to soften scar tissue, a resolvent action.

Since these two actions are exactly the ones that might be of help in overcoming tubal occlusion, I tried the use of a simple iodine preparation, syrup of hydriodic acid, on three patients who had persistent tubal occlusion, with success in two cases.

CASE REPORTS

Mrs. R., age thirty-seven, was married five years. The history revealed nothing of importance. Physical findings including pelvic examination were essentially normal. Tubal insufflation was done in the hospital under ether anesthesia.

Gas pressure (CO_2) was raised to 40 mm. Hg, held a few moments and then released. Pressure was raised to 60 mm. Hg and released. This procedure was continued with increments of 20 mm. Hg each step until 200 mm. Hg was reached, the pressure being held for about ten seconds each time. Pressure was raised to 200 mm. Hg three more times without the steps, making four times in all with no flow of gas being noted.

The patient was given syrup of hydriodic acid (ʒii,) in water after meals and at bedtime for two months. Following this tubal insuffla- was repeated, this time in the office, with no sedation. Gas flow began at 150 to 160 mm. Hg pressure. Using a total of about 800 cc. of gas, apparently both tubes were opened. Before the operation was finished, the gas was flowing in good volume at a pressure of 30 to 40 mm. Hg. Severe shoulder pain followed.

This patient became pregnant five months later.

Mrs. H., age thirty-five, was married twenty-three months when first seen. Physical findings including pelvic examination were essentially normal. The patient had previously consulted three physicians, two of them of outstanding ability in the treatment of sterility, regarding her failure to become pregnant. All three physicians had tried tubal insufflation, one under general anesthesia, and all had reported non-patency of the tubes. She had taken large amounts of desiccated thyroid.

Before undertaking any other treatment the patient was given syrup of hydriodic acid (ʒii) four times daily for ten weeks. Following this she was admitted to the hospital.

Tubal insufflation was done under sodium pentothal® anesthesia. Gas (CO_2) flowed apparently through one tube only at a pressure beginning at 190 to 200 mm. Hg. About 400 to 500 cc. of gas were used but good flow could not be obtained below 90 mm. Hg. I did not have the feeling that the tube was wide open. The patient experienced shoulder pain on awakening.

Three months later tubal insufflation was repeated in the office. During the interval she had taken the medicine part of the time. Gas began to flow at 190 mm. Hg; approximately 1,000 cc. in all of gas were used. The flow of gas which was of fair volume at first increased as the operation progressed. By the time it was finished there was a good flow of gas at 30 mm. Hg. The patient had distended abdomen and shoulder pain.

The iodide treatment was tried on one other patient, age thirty-two, who gave a history of having undergone an induced abortion at seventeen, apparently followed by infection. Pelvic examination showed nothing abnormal. Tubal insufflation in the office revealed closed tubes. The patient was given syrup of hydriodic acid for two months and tubal insufflation was repeated, without success. She has undergone further treatment.

The two successful cases offer little in the way of proof of the efficacy of a therapeutic measure. It would seem worth while to give iodide therapy a trial in patients with persistent tubal occlusion.

A warning is to be noted in the use of iodides. "Iodide should not be used in any case suspected of tuberculosis because of the danger of its increasing the activity of the disease."[2] Before starting this treatment a careful inquiry should be made to rule out the possibility of the patient's suffering from tuberculosis, even in a healed condition.

Also, it probably would be unwise to attempt the use of iodides in cases of barren marriage without concomitant tubal insufflation.

SUMMARY

In the treatment of sterility in women many cases of tubal occlusion are found to be due to the presence of thick mucus in the lumen of the tubes and to adhesions and scarring as the end result of inflammation.

Among the actions ascribed to ingested iodides are the ability to lower the viscosity of mucous secretions and the resolvent action on scar tissue.

From these two premises it would appear that the use of iodides might be of value in the treatment of tubal occlusion.

Three patients with occluded fallopian tubes were given syrup of hydriodic acid orally for a period of weeks. Following this, tubal insufflation was repeated and in two patients the tubes were opened easily.

Iodides should not be given to a patient who has had tuberculosis.

Further study of the effect of iodides on patients with persistent tubal occlusion is warranted.

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New Instruments

INSTRUMENT FOR THE DETECTION OF GALLSTONES IN THE BILE DUCTS*

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FOLLOWING exploration of the bile ducts for gallstones the surgeon can seldom be certain that all stones have been removed. Not infrequently an unremoved stone is seen in the postoperative cholangiogram or is later found to be the cause of recurrent symptoms. This problem has been extensively discussed in the literature on biliary tract surgery but few attempts have been made to determine the frequency of retained stones. Pribram,[1] who recently reviewed the statistical studies which have been made, concluded that the incidence is from 16 to 25 per cent.

The problem of unremoved stones in the biliary ducts is principally a problem of detection. If a stone is known to be present, its removal is probably always technically possible. A transduodenal or posterior transpancreatic approach may be required to dislodge stones impacted in the distal end of the common duct, and repeated grasping and crushing maneuvers may be necessary in removing stones from the hepatic ducts.

Stones which are missed cannot be seen and usually cannot be felt. Their presence is often not suspected with current methods of exploration. Probing is seldom decisive because of the damping effect of tissues and rubber gloves. The passage of probes and the free flow of irrigating solutions into the duodenum does not always exclude the presence of stones in the ampulla of Vater. Palpation of tissues adjacent to a firm catheter passed into the duodenum is a valuable maneuver but may not be reliable in the presence of much adipose tissue or a nodular pancreas. Failure to pass probes or catheters into the duodenum poses the difficult question of whether to expose the distal end of the common duct by the transduodenal or posterior approach. The increased risk cannot be undertaken lightly unless a stone is known to be present. Exploration high in the hepatic ducts is even less satisfactory than exploration of the common duct, the most reliable maneuver being the repeated passage of scoops and grasping forceps. Operative cholangiography,[2] a procedure of considerable merit, has not been widely accepted because the operative procedure is prolonged, additional equipment and personnel are required and interpretation of the films may be difficult and confusing.

In an attempt to clarify further the detection of stones in the extrahepatic ductal system the development of an improved method of gallstone detection was discussed with Professor Eric A. Walker, head of the Department of Electrical Engineering of the Pennsylvania State College, and members of his staff. The actual design and development of the device were undertaken by Edward G. Thurston. Technical details have been described in an earlier paper,[3] and the latest model* is shown in Figure 1.

The principle of operation of the instrument is simple. It is an electro-acoustic device which makes audible the contrast between contact of a metal probe with a gallstone and with adjacent tissue. A Bakes dilator of any size is mounted in a handle housing a sensitive element (electrostrictive ceramic). The shock waves produced by contact with a gallstone are transformed by the sensitive element into a voltage which passes through a microphone cable to an amplifier. The voltage is amplified

* The Kirby-Thurston Cholelithophone, manufactured by the Centre Electronic Manufacturing and Engineering Co., State College, Pa., and distributed by George P. Pilling and Son, Philadelphia, Pa.

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FIG. 1. Front view of the gallstone detector; the amplification unit is in a stainless steel case, with control dials on the face. Two probes (Bakes dilators), the handle containing the crystal, and the connecting cord are in the foreground.

and made to operate a loudspeaker. Contact with a gallstone produces a characteristic clicking sound which may be heard by amplification throughout the operating room. Contact with tissue produces no sound or, at times, a soft hissing or scratching sound.

The Bakes dilator, handle and electric cord are sterilized in zephiran and kept on the instrument table. When ready for use the end of the microphone cable is passed to a floor nurse who plugs it into the amplifier. The volume of sound (degree of amplification) and the quality of the tone produced are controlled by dials on the face of the amplifier. The Bakes dilator attached to the handle housing the sensitive element is used to explore the biliary passages in the same manner as is any bile duct probe. Although slight contact with a stone will produce a click, a gentle tapping motion has been found helpful in producing the clearest signal.

CLINICAL EXPERIENCE

The gallstone detector has been used by staff members of the Department of Surgery of the Hospital of the University of Pennsylvania during exploration of the common and hepatic bile ducts in fifty-five patients. The results of exploration have fallen into four categories as follows:

No Stones Found. In twenty-nine instances exploration by the usual technics was negative for stones and the detector gave no evidence of the presence of stones. All postoperative cholangiograms were normal.

Soft Biliary Tract "Mud," No Stones Found. In five patients the bile ducts contained soft "mud" and no formed stones were found. On tapping the "mud" the characteristic clicking sound was heard in three while in two it was not. The "mud" was removed with scoops and by irrigation and all postoperative cholangiograms were negative.

Stones Present, Confirmed by Gallstone Detector. In thirteen patients with stones the characteristic click was confirmed with the detector before or during removal of the stones. It is not believed that any of these stones would have been missed without the detector. In some instances "mud" was present in addition to the formed stones. All postoperative cholangiograms were normal.

Stones Missed, Found by Gallstone Detector. In eight instances the detector located stones which in the opinion of the operator probably would not have been detected or removed without its use. In two patients the duodenum was opened to remove stones impacted in the ampulla of Vater. In one of these patients catheters and probes could be passed into the duodenum past the stones before using the detector while in the other they could not. Postoperative cholangiograms were negative in all except one patient in whom the detector gave the characteristic stone signal high in the right hepatic duct despite repeated efforts to clear the duct. Postoperative x-rays showed stones remaining in this location. This was one of the first patients in whom the detector was used, and false positive clicks were considered at the close of the operation to be a possible cause of the persistent gallstone signals.

Uses in Cholelithiasis and Cholecystostomy. In three instances of cholelithiasis the common duct has been explored with the gallstone detector through the stump of the cystic duct, without opening the common duct, after removal of the gallbladder. Exploration with the detector in these cases appeared to be almost as satisfactory as if the common duct had been opened. In selected patients who do not have a narrow cystic duct or an anomalous junction of the cystic with the common duct, exploration in this manner may be a satisfactory substitute for exploration through a common duct incision to confirm the necessity for opening the common duct if stones are present.

In three instances the gallstone detector has been used to search for stones in the gallbladder during cholecystostomy. Stones have been

easily identified and the detector has appeared superior for this purpose to the cholecystoscope. In the presence of sufficient edema to make palpation unreliable the detector might be particularly helpful in determining whether a stone or stones are impacted in the opening of the cystic duct.

COMMENTS

Since gentle tapping of any well formed gallstone produces a clear and easily audible clicking sound in the amplifier, stones with which the probe can be brought into contact should seldom be missed by the detector. The interposition of tissue between the probe and the stone has a marked damping effect which would probably interfere with detection in the unusual instance in which the stone cannot be tapped directly, e.g., a stone on the pancreatic side of a common pancreatic and choledochal ampulla. Although tapping of biliary tract "mud" has given the characteristic signal in some instances, it seems unlikely that very soft stones and "mud" can be detected with any degree of reliability. Any soft material which may remain after thorough scooping and irrigation rarely causes obstruction, in our experience, and responds well to Pribram irrigations.

SUMMARY

A new instrument has been described which aids in the detection of gallstones during exploration of the bile ducts. It is an electro-acoustic device which makes audible the contrast between the contact of a metal probe with a gallstone and with adjacent tissue. In eight of fifty-five patients in whom it has been used gallstones have been detected which, without its use, probably would not have been removed at the primary operation.

Acknowledgment. The author wishes to acknowledge his indebtedness to Professor E. A. Walker and to E. G. Thurston of the Department of Electrical Engineering of the Pennsylvania State College, whose technical knowledge and skill have been so largely responsible for the development of this device.

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MALLET EMPLOYED IN THE PERFORMANCE OF SURGICAL PROCEDURES ON BONE

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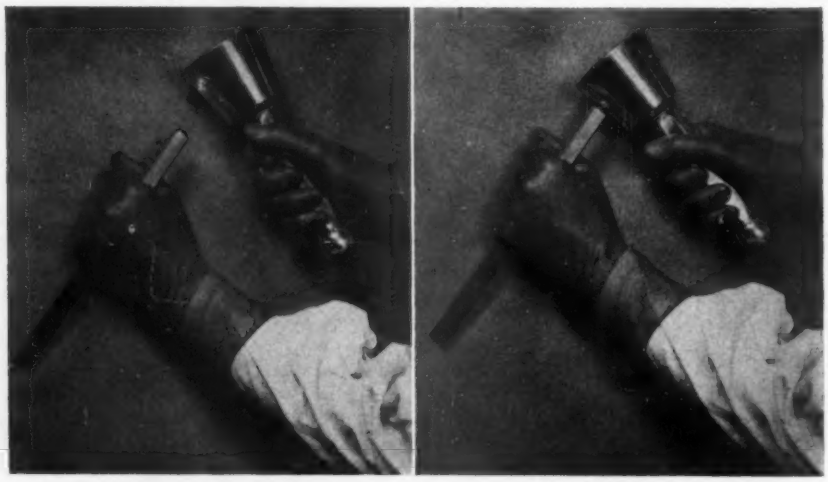
A MALLET which I designed in 1915[1] has been widely employed in the performance of operations on bone for many years. This bone mallet has been modified by giving it more weight and more strength so that it is more effective. The advantage of the new type of mallet is that the surgeon is able to watch the cutting edge of the chisel and accurately gauge the force of the blow with a minimum of effort and without striking his hand or tearing his glove. This mallet has sufficient weight so that it can be grasped close to the head and a light blow imparted to the chisel; also, it can be grasped further toward the end of the handle and still by wrist action the mallet strikes sufficiently hard to give any desired force. Wrist action is all that is required because of the weight of the mallet. Furthermore, this mallet is made more conical in shape so that it may be used to impart the force of the blow directly through the chisel; thus it does not tend to divert the cutting edge. In other words it permits the surgeon to strike the head at right angles with the chisel and in the center of the head of it, and at the same time to keep his eye on the cutting edge. I have often seen surgeons attempting to work with too light a hammer; in striking the chisel forcefully they miss the head. A light instrument makes the operation more difficult and there is danger of sustaining injury to the hand or glove or both.



1A 1B

FIG. 1. Surgical mallet; before (A) and after (B) striking the head of the chisel.

The new mallet is made of an alloy which does not tarnish and is thicker and thus stronger at the base of the head than the one described previously. It should last a surgeon for an indefinite period. It is 8¾ inches (22.2 cm.) in length, weighs 2 pounds (0.9 kg.) and has a handle that is hexagonal which facilitates grasping and holding it firmly. (Fig. 1.)

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SUCTION MODIFICATION OF THE PADGETT-HOOD DERMATOME*

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THE purpose of this report is to describe a modification of the Padgett-Hood dermatome[1,2] which has been found to insure satisfactory grafts in a larger proportion of attempts.

It is common experience in using the Padgett-Hood dermatome that if satisfactory initial strokes are made with the dermatome blade, the remainder of the graft will be obtained without difficulty because an increasingly effective grip on the skin surface develops as the drum is rotated. The greatest problem is to provide sufficient cohesion of the drum and the skin so that the two surfaces will not be separated by the rotary motion of the leading edge of the drum or by pressure on the skin by the cutting edge of the blade.

Separation of the skin from the drum is usually ascribed to the poor quality of the rubber cement, failure to allow enough time for it to become sufficiently tacky, fixation of the donor site to the underlying tissues preventing the skin from being lifted by the leading edge of the drum and, probably the most important, a blade sufficiently dull to separate the skin from the drum instead of cutting into it. Despite these difficulties there is usually little trouble in securing a suitable graft in adults from such broad, flat surfaces as the abdomen, back or the inner and outer aspects of the thighs. At once the suggestion that some additional help is needed may be considered to be not only unnecessary but also an admission of ineptitude in the use of the instrument. However, in children with extensive burns the surfaces which can be used for donor sites are limited. Further, the nutritional state which soon develops renders the ribs and bony landmarks prominent. As a result the contour of the available donor sites is such that satisfactory use of the dermatome is difficult unless the skin can be made to remain in contact with the drum regardless of considerable traction at the ends of the leading edge of the drum as it is rotated to begin cutting the graft. It is evident that some additional means of securing a firm grasp on the first edge of skin to be raised is desirable. In fact Sheehan[3] has equipped a dermatome with prongs to catch the skin not only along the leading edge but at the sides of the drum as well.

It seemed reasonable that a suction device could be incorporated into the leading edge of the dermatome drum to provide greater cohesion between the skin and that part of the drum and to make more certain a satisfactory start in cutting the graft. The modification shown in Figure 1 has proven to be extremely useful in this way. Suction is applied through perforations in the drum. These perforations open into metal tubes fastened to the inner surface of the drum. A portion of each tube forms the nozzle to which the suction is applied. There are two rows of perforations 1.4 mm. in diameter placed at intervals of approximately 1 cm. The first row of perforations which are placed 7 mm. from the leading edge extends the full width of the drum. The second row placed 13 mm. from the leading edge extends only across the middle two-fourths of the drum. Since all the openings in the row used must be covered in order to develop effective

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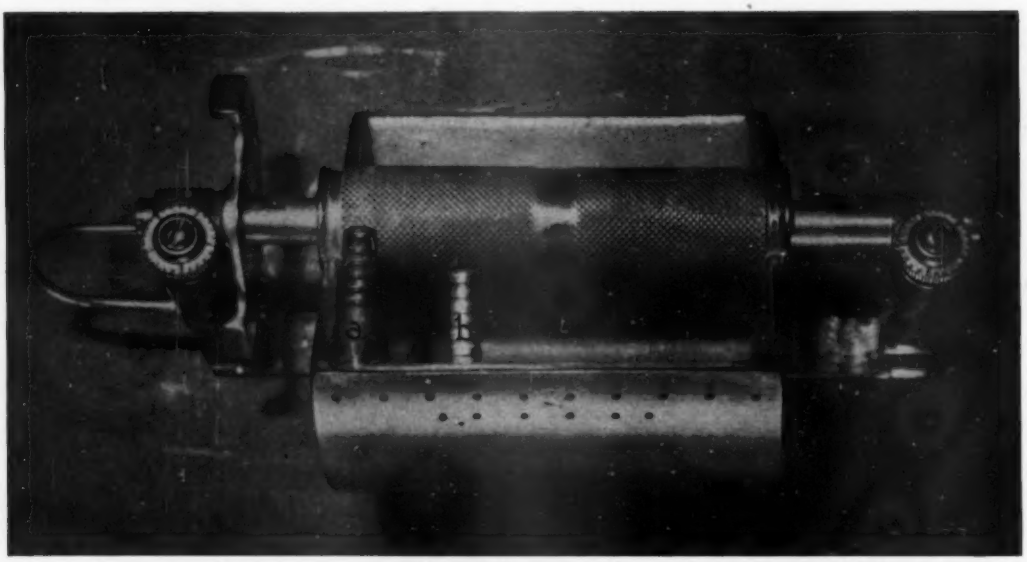

FIG. 1. Dermatome. The upper row of perforations opens into a channel into which the nozzle (*a*) leads; nozzle (*b*) is connected to a similar channel which applies suction to the second row of (six) perforations.

suction, the longer row is used when a graft the full width of the drum is needed. The second row of perforations is provided for use when a narrower graft is needed or where the contour of the donor site does not permit contact with the entire width of the drum at or near the leading edge.

The preparation and use of the dermatome equipped with the suction modification is quite similar to that of the standard model. The surfaces of both skin and drum are thoroughly cleansed with ether. Rubber cement of satisfactory consistency is applied evenly and thinly to the skin and drum with long uninterrupted strokes and allowed to dry until definitely tacky. A rubber tube leading from a standard operating room suction apparatus is attached to the proper nozzle. The leading edge of the drum is pressed down on the skin surface with sufficient pressure to obtain firm cohesion of the cemented surfaces and the graft is cut with the usual dermatome technic.

It has been the author's experience, based on the use of the modification herein described since June 28, 1946, that a higher proportion of satisfactory grafts has been obtained from skin surfaces which would otherwise be considered unsatisfactory donor sites.

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